ARMY ORDNANCE

VOL. XXVII, No. 146 SEPTEMBER-OCTOBER, 1944

Automotive Spare Parts
Brig. Gen. Julian S. Hatcher

Birth of the Bazooka
Col. L. A. Skinner

The Age of Valor
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Ordnance on the Battlefield
Lieut. Col. W. C. Farmer

Our 240-mm. Howitzer
Lieut. Col. G. M. Yatsevitch

The Jeep in Action
Maj. E. P. Hogan

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.

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ARMY ORDNANCE

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Founded 1920

For Victory through Armament Research, Production, and Supply

Volume XXVII SEPTEMBER-OCTOBER, 1944 No. 146

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Attack

ARMY ORDNANCE

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Automotive Spare Parts

Problem Children of the Gasoline Engine

Brig. Gen. Julian S. Hatcher

As we approach the third anniversary of Pearl Harbor, it becomes crystal clear that no subject of conversation involves so little understanding or so much misunderstanding as the one which revolves around the question of spare parts. There are so many facets to the subject that to distinguish them, one from the other, would require more space than is available in a single article in ARMY ORDNANCE and more time than it is possible to divert from the urgency of overseas supply to discussion rather than action.

However, a contribution, no matter how brief, which clarifies the basic difference between the military use and demand for spare parts and their commercial use and demand may be of value at this time. For, after three years of war, there is no lessening of demand for spare parts for the military machine, and civilian economy is beginning to feel the pinch of its loyal support of the Army's needs.

That the civilian economy is at all involved turns the subject of spare parts immediately to the gasoline engine and its related components. Civilian economy never has been much concerned with spare parts for guns, howitzers, fire-control instruments, small arms, and automatic weapons. Conversely, these elements of "shooting ordnance," by the very fact that they are not the products of even limited civilian use, have never had serious spare-parts problems. The reason may be attributed, in large degree, to the fact that these are mostly Ordnance-designed and have not, as has the automobile, been turned from the pursuits of pleasure and commerce to face tasks and tests to which only troops, fighting a total war against a determined enemy, could subject them. Even the most far-seeing automotive designer never considered it profitable to make, for civilian use, a vehicle with a front-wheel-drive mechanism, as well as one for the rear wheels. The Army found that necessary to meet requirements for a war which might have to be waged in strange lands and upon unfamiliar terrains, far removed from paved highways and roadside repair shops.

Most of the operational reasons for the diversity of spare-parts requirements are now familiar to officers and men in the Ordnance service units, and, to a considerable degree, to officers and men in the combat forces who use Ordnance equipment. What is new are the contributing reasons, which may now be told, leading up to many of the early decisions necessitated by the spare-parts requirements at the time. An earlier telling of the story might have given aid and comfort to the enemy.

General Hatcher is chief of Ordnance Field Service and is responsible for the operation and administration of the supply, storage, and maintenance functions of the Ordnance Department. He was formerly in charge of Ordnance training responsibilities and established the great Ordnance Training Center at Aberdeen Proving Ground, Md. He is a recognized authority on small arms and small-arms ammunition, being the author of many authentic texts on these subjects.

There are two classes of spare parts: *Concurrent spares* are procured at the time the vehicle is purchased, and *replenishment spares* are those procured, as the name implies, for the restockage of requirements depending upon usage.

One of the comments most frequently heard is that the lists of original concurrent spares included many parts which, on the basis of commercial experience, would not be likely to be replaced, at least in the quantity provided in the list, in the first year's use of the vehicle. It was stated further that, as a consequence, large stocks of slow-moving spare parts have been built up in various locations, such as the North African theater, and that the Army is now faced with the problem of disposing of such stocks of excess parts.

The underlying thought implicit in such a comment appears to be that because inadequate attention was accorded prior commercial experience in the preparation of initial spare-parts lists, excesses of parts were later created in the theaters of operation. This thought is definitely incorrect. The importance of the factor of commercial experience in the preparation of Army parts lists has been misunderstood.

ALTHOUGH commercial-usage experience has been and is of some value in determining the content of concurrent spare-parts lists, that value is comparatively minor when measured against military-usage experience and conditions of military supply. This proposition becomes crystal clear when consideration is accorded to the great differences which exist between commercial military conditions of, and experience in, motor-vehicle usage. Of these differences the most significant, in so far as the determination of the content of automotive concurrent spare-parts lists is concerned, is that Army spare parts are bought solely for field maintenance, divided into these five echelons: (1) Preventive maintenance by the vehicle operator; (2) Preventive maintenance by the operating organization; (3) Major and minor unit-assembly exchange in field shop; (4) Major and minor unit-assembly exchange in general-purpose vehicle repair at base shop; (5) Major unit-assembly rebuild and tank and combat-vehicle rebuild at base shop.

Most parts lists for the first year of vehicle usage, if based purely on commercial experience respecting parts requirements, would probably include parts adequate for only the first three echelons of Army maintenance. Further, if, as in commercial usage, the parts could be stored in and made available from central warehouses from which they could be withdrawn readily as needed, the quantities of parts included on Army lists probably could be reduced. However, it is a fundamental military principle inherent in the very nature of warfare that every Army echelon must be equipped with supplies and parts so as to be self-sustaining in the field

to the greatest possible extent for considerable periods of time. Furthermore, current widespread operations require many parts stock piles in theaters of combat in order to ensure continuous supply to using organizations wherever they may be.

In the Pacific theaters where "island warfare" prevails, this creates an unusually lengthy pipeline of supply and makes for difficult problems in logistics. For example, in the Southwest Pacific theater, at the beginning of 1944, eleven depots were in operation at widely separated coastal points extending from Melbourne, Australia, as far north as Finsababu, New Guinea. Due to shipping conditions and the great distances involved, a substantial portion of the theater's stock is constantly in transit. The Army distribution factor, therefore, is a factor in military experience of great magnitude which has no counterpart in commercial automotive experience.

AUTOMOTIVE parts are not stocked by industry for sale to the Army as they are stocked by industry for sale to its peacetime commercial outlets. Parts for the Army are manufactured only on firm Government orders and are not taken off existing shelf stocks. Consequently, it is necessary that spare-parts requirements be anticipated from ten months to a year in advance of delivery to allow for Controlled Material Plan allocations, manufacturing schedules, priorities, and other wartime production factors. Thus, a spare-parts procurement list, when prepared, must contemplate possible combat conditions a year in advance. Commercial experience provides no standard to compensate for such factors.

It is quite frequently heard that certain situations have not been met at the exact moment of demand. Because of the factor previously mentioned, and because of the uncertainty when a contract is awarded as to where spare parts being produced will be required for use, sound judgment has dictated the desirability of including in spare-parts procurement lists parts items which would tend to make the set usable in *any* theater of operations. Parts lists must therefore be established for average conditions of usage anywhere. Any given spare-parts lists would thereupon be suitable for use in either Alaska, the South Pacific, England, Italy, etc. Consequently, when unpredictable and unforeseeable conditions peculiar to particular theaters are encountered, the quantities included in the list may be deficient in some respects and excessive in others. Of course, when such a condition is discovered or can be foreseen, immediate steps are taken to remedy it; the factor, nevertheless, exists and is peculiarly significant in the light of the present widespread military operations. There is no parallel to this condition in commercial experience.

Civilian automotive equipment is usually operated on surfaced roads under the most ideal conditions of usage; military automotive equipment operates over all extremes of terrain and in all extremes of climate. There is little relation indeed between civilian commercial operation with its schedules, limitations of territory, regular servicing and overhauling by maintenance experts, and latest and best equipment, and field combat conditions with the inherent limitations of maintenance equipment and skilled personnel in vehicle echelon maintenance. Furthermore, in the exigencies of combat, Army vehicles are frequently subjected to extreme-capacity performance regardless of good mechanical or operational standards. Similarly, tactical situations involving protracted advances or retreats or sudden unpredictable movements frequently eliminate the application of sound preventive maintenance. Commercial vehicles, of course, do not operate under such conditions.

The quantity of major assemblies procured by the Army is often another subject of discussion which has not been widely explained. Frequently the lack of base shops for fourth- and fifth-echelon maintenance in initial operations in overseas theaters necessitates the parts-requirements planners to treat major unit assemblies as expendable items. Under civilian automotive practices, no major assembly unit, such as an engine transmission or differential, is ever discarded until rebuilding is uneconomical. In expanding operations and beach landings, however, frequently no base shops are available, and vehicles must be kept running by major-assembly replacement. Hence, Ordnance requirements for these assemblies must be figured accordingly.

This does not mean, of course, that complex assemblies with one or two worn parts which, because of tactical necessity, are replaced by new assemblies in the field, are completely discarded. Eventually base shops may be established in the field and these assemblies rebuilt and reclaimed, but no certainty as to this possibility exists, and therefore it must be largely discounted by the spare-parts procurement list projector.

UNPREDICTABLE changes in tactical strategy constitute one factor in spare-parts requirements which all military personnel take into consideration but which is unfamiliar to civilians. Completely unpredictable changes in combat strategy or tactical situations definitely and directly influence spare-parts requirements. Usually factors are completely unforeseeable when the spare-parts procurement lists are prepared. There is no parallel to this, of course, in commercial experience. These unpredictable contingencies may so affect parts supply as to be productive either of excesses on one hand or shortages on the other. For example, originally the organization of the Ground Forces was planned on the basis of a large number of armored divisions. As the strategy and tactics of the war changed, however, a lesser number of armored divisions was activated, and plans for the balance were canceled. In the meantime, of course, many items, including spare parts, had been purchased for the organizations originally contemplated.

Many projections of first-year parts requirements were made when submarine warfare was at its height and a heavy percentage factor for sea losses had to be considered. Since then, losses from submarine action have been considerably reduced and the shipping-loss factor in spare-parts requirements calculations has been disregarded.

Army vehicles are now in use all over the world. The vehicles located in the many different theaters are the same makes and models, but the spare-parts items required for their maintenance varies greatly due to conditions peculiar to each theater. The nature of these conditions and their effect on spare-parts requirements are almost entirely unpredictable as of the time spare-parts procurement lists are prepared. Yet they, too, are an important factor both in the preparation of the lists and in the creation of spare-parts shortages or excesses within the theaters. And, of course, civilian parts-usage experience contains no such equivalent factor. A few examples will serve to demonstrate the importance and effect of this.

The unexpected extensive use of land mines in North

Africa blew up the front end of many vehicles. At about the same time, however, many rear axles of comparable vehicles were being broken by overloading in the South Pacific. The result, therefore, was the creation of unexpected surpluses of rear parts in North Africa and of front parts in the South Pacific with a corresponding shortage of front parts in North Africa and of rear parts in the South Pacific.

At one point in the North African campaign the experience of the British and American armies had established an annual replacement factor in radiator cores of one hundred per cent because of alkaline water and enemy action. When this unexpected condition was first encountered there was consequently a serious shortage in radiator cores. Our engineers effected changes in the cores and improved the armor protection of the vehicle, and the new radiator cores were purchased in large quantities. Desert warfare ended abruptly, however, and large stocks of radiator cores became excess to our needs in that theater.

ANOTHER typical example of what has occurred in numerous instances is found in the howitzer motor carriage M7. At first, this was an immense success and one of the important factors in the victory at El Alamein. Requirements projections were made accordingly and spare parts procured for the extensive use of this weapon. However, as the desert warfare became less wide ranged and fluid near Tunisia, the advantages of speed and firepower provided by the M7 were to some extent overcome by the greater defensive skill of the enemy which necessitated more protection for the crew. The use of the vehicle was thereupon curtailed, and other heavier armored vehicles were provided to the theater in a matter of months. Now, of course, many of the spare parts purchased for the extensive use of the M7 originally contemplated appear to be in excess of the present need.

All these situations and conditions indicate the important factors which spell out the vast distinction between military and commercial parts-supply problems. These same factors serve to demonstrate in a realistic fashion the enormous difficulties and uncertainties involved in determining spare-parts procurement lists. Finally, these same factors furnish the basic underlying causes for the creation of spare-parts surpluses or shortages in all theaters, including the North African.

It should be quite apparent from the wide variety of questions that have been asked from time to time about spare parts that uniform answers have not been given to inquiries from various sources. An over-all statement of the methods and terminology utilized in connection with the determination, procurement, distribution, and replenishment of Ordnance spare parts will acquaint unfamiliar persons as to current practices and afford a background of information which should clarify the subject in future discussions.

First of these is "Determination of spare-parts lists." The Chief of Ordnance is responsible for the preparation of spare-parts lists (officially known as essential extra-parts lists) for all ordnance matériel. These lists designate those parts which are authorized for issue to all echelons of maintenance and the estimated quantities thereof required to maintain each weapon, vehicle, or other Ordnance item for the first year of operation. The lists are approved by Headquarters, Army Service Forces, and these parts are then procured concurrently with the major Ordnance item.

A standard-nomenclature list (actually an Ordnance catalog) is published by the Ordnance Department for each major weapon, vehicle, and other Ordnance item, listing all parts and showing part number, code number, parts authorized for issue, and the distribution of such parts for each echelon of maintenance. These SNL's, as they are known, are distributed by The Adjutant General's Office to all maintenance and supply organizations throughout the world.

Next comes "Procurement of estimated first year's spare parts." Spare parts estimated to be required for one year's maintenance are purchased and manufactured concurrently with the weapons, vehicles, or other Ordnance items to which they apply. They are delivered on the basis of a fixed number of sets of parts with a given quantity of the completed weapon, vehicle, or other Ordnance item.

Finally there is "Distribution of first year's spare parts." The distribution of estimated first year's spare parts procured concurrently varies as to whether the weapons, vehicles, or other Ordnance items are for domestic use of the Army, for the Army overseas, the Navy, Marine Corps, or for International Aid countries. The general pattern is in four classifications:

1. For Army domestic use, all parts are shipped to Ordnance depots, and further distribution is made in turn to service-command supply points as required or diverted to overseas theaters as the need arises.

2. For the Army overseas, an estimated six months' supply of spare parts for all echelons of maintenance is usually shipped at the time the weapons, vehicles, or other Ordnance items are shipped. The balance is carried at Ordnance depots to fill replenishment requirements on request from overseas theater commanders.

3. In the case of the Navy and Marine Corps, the entire first year's spare parts are shipped with the major items.

4. For International Aid countries, first year's spares are shipped complete and concurrently as the major items are shipped.

Next in order in the major terminology and practices is "Replenishment spare parts and special overseas demands." Replenishment spare parts ordinarily must be ordered from manufacturers from six to nine months in advance of anticipated needs because of the requirements of the Controlled Materials Plan for raw materials and the necessity for setting schedules in the manufacturing plants. Replenishment requirements normally cover parts estimated to be needed for the subsequent year's maintenance of the major items.

MUCH is said about "interchangeability." Continuing study of interchangeability of parts is maintained, and interchangeability lists are compiled. These lists are furnished to all supply points so that the best possible utilization can be made of available stocks. Where standard or common parts are used, such as nuts, bolts, spark plugs, tires, etc., such parts are stocked and issued as "parts-common" items.

"Distribution and stock levels" is another important subject. There are established by Headquarters, Army Service Forces, prescribed stock levels in terms of days of supply, applicable to both domestic and overseas stocks. These levels apply to Ordnance distribution and export depots and to service-command supply points which supply maintenance parts to posts, camps, and stations throughout the United States. Varying levels have been prescribed for the different overseas theaters of operation to allow for varying transit time. The determination of the items and quantities involved resides in the theater commander.

The New Folding Bazooka Rocket Launcher

The new folding bazooka, shown at the left in the Ordnance photo above, is now replacing the former long one-piece type, shown at the right, for use in jungle warfare, and by paratroopers, landing forces, and other combat groups who travel under limited-space conditions and fight at close quarters. It has proved as effective as the regular bazooka.

Birth of the Bazooka

The Genesis of a Powerful Portable Antitank Weapon

Col. L. A. Skinner

EARLY in the summer of 1942 the Ordnance Department left on the doorstep of the Army Ground Forces a new baby that had all the grace and charm of a Mongolian idiot, but which for its size has seldom been equaled for pure cussedness. Now, having gone through more than a year of battlefield tests, the understandable suspicion in the minds of both those who developed it and those who use it has now given way to a certain amount of respect and even a modicum of pride.

The "bazooka," for so the object was named, came about in rather a devious fashion and was compounded with the aid and advice of the several persons to be named herein. The account is given as a possible item of interest to the readers of ARMY ORDNANCE and as a factual record of what actually took place. An amusing sidelight is the way the number of "inventors" of the bazooka has fallen and risen as troubles developed and were cured, the stage having been reached in one part of its career where only those who worked on it could be found to claim any connection with it.

THIS manuscript by Colonel Skinner describes the first steps in one of the most phenomenal weapon developments of the present war. It is more than a simple narrative. It connotes the long years of research by all concerned in the evolution of principles not heretofore fully utilized.

I would like to see published from time to time similar articles on other unique Ordnance developments. It is incumbent upon all of us to put into the record for the guidance of future generations the simple factual story of progress in order that some of the individuals concerned may be known and their work adequately appraised. This is a secondary consideration of Colonel Skinner's manuscript, but it is as important as rocket development itself.—MAJ. GEN. L. H. CAMPBELL, JR., Chief of Ordnance, U. S. Army.

The idea of projecting a grenade with a rocket is, of course, a very old one, but the *idea* of doing it and *actually designing* a rocket using high-potential powders to do it are two different things. Just such a design was discussed with Col. Gregory J. Kessenich of the Patent Section of the Office of the Chief of Ordnance, in December 1940, and a sketch on which the present launcher, M1, is based was shown to him by the writer, who also made the first basic design of shoulder launcher turned out at Frankford Arsenal in the spring of 1942. It appeared, however, that there was no need of such a rocket-propelled grenade and certainly there was no interest in one, but in April 1941 Colonel Kessenich brought to my attention, without disclosing the details, the fact that there was being developed in the Ordnance Department a new type of armor-piercing projectile which did not require high striking velocity to be effective.

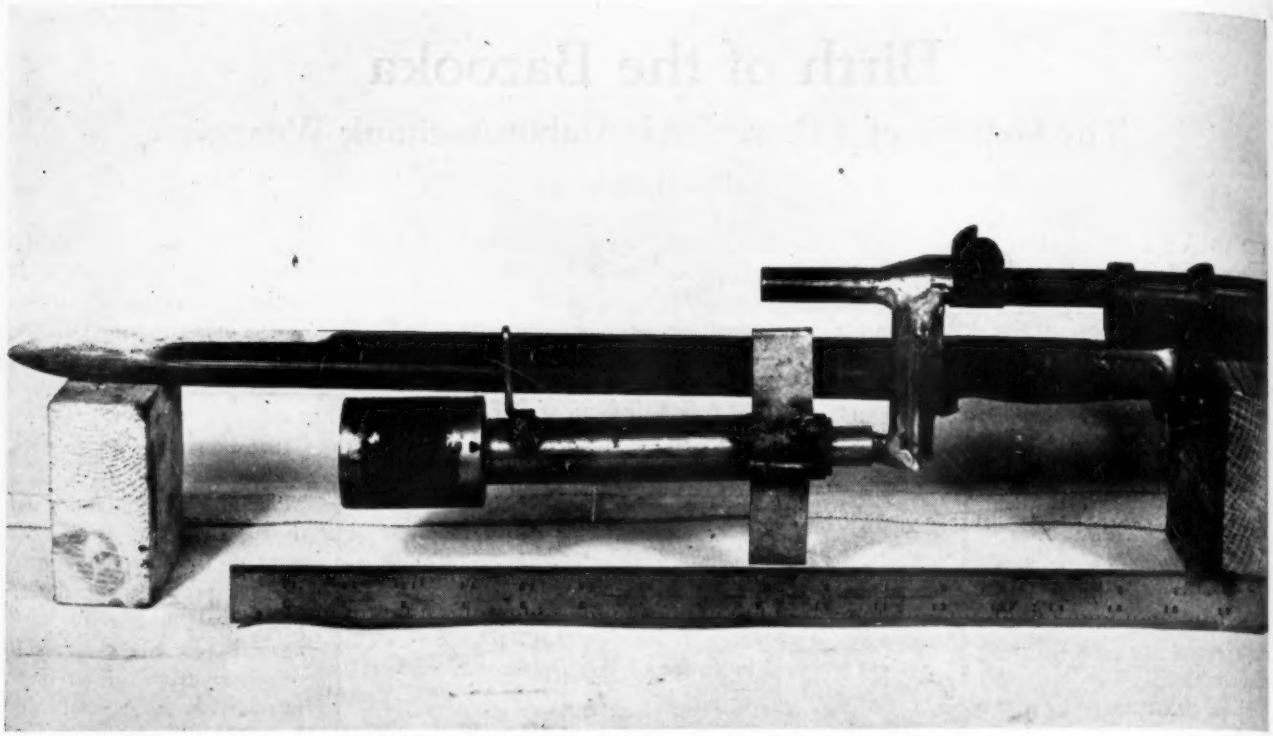
A design for the type of projectile referred to, now as well-known to our enemies as to ourselves, was brought to this country by a young Swiss engineer, Henry H. Mohaupt, now a private in the Ordnance Department of the Army. It was submitted to the then-existing Technical Staff for consideration, which it received from Brig. Gen. R. H. Somers (past editor of ARMY ORDNANCE) and Col. K. F. Adamson in spite of the general disbelief that it could meet the claims made for it by Mr. Mohaupt, its designer. I use the term "designer" rather than "inventor" in connection with this projectile, as I do for the rocket, because in both cases the basic invention had been known for some time and the present outgrowths are ingenious and reasonably intelligent combinations of old principles into a practical device which legally may be an invention but certainly not a basic one.

Under the impetus given by General Somers and his staff, models were made to Mr. Mohaupt's design and tried in 1941. To the surprise of most of the few who knew of the project, the device performed amazingly well against armor. As a result of these trials, a grenade fitted with the special Mohaupt head and designed to be fired from a spigot launcher was produced and standardized as the "Grenade, High-explosive, Antitank, M10." It was a formidable projectile except for one thing; it could not be fired practically from the shoulder rifle, the caliber .50 machine gun, or the special projectors built for it because of the heavy recoil. As originally designed, the projectile weighed about three pounds and had a maximum velocity of about 240 feet a second.

AS a result of various conversations with Colonel Kessenich during the winter of 1941, and being the Army's rocket organization at that time, I had been working off and on at the design of a small double-base powder rocket, doing the machine work in my basement shop. However, no firing was done until May 1941 and that with very crude designs. In June 1941, the rocket unit of the Ordnance Department was increased at least one hundred per cent by the addition of Lieut. E. G. Uhl, a most fortunate choice, although a blind one on my part, because his excellent background of training and his willingness to work enthusiastically under our early handicaps fitted him most admirably for the job in which he played such an important part.

After Lieutenant Uhl's assignment to the special projects unit, Bomb and Pyrotechnic Section, Ammunition Branch, Ordnance Industrial Division, the work was carried out jointly, with Lieutenant Uhl doing most of the design and firing on homemade models at the jet-propulsion laboratory of the Navy and the National Defense Research Committee. Dr. C. N. Hickman, of the N.D.R.C. and Bell Laboratory, who had done considerable work on rockets during World War I, was the technical director of this laboratory, with the writer as technical director of Army projects. Since

Colonel Skinner is a member of the Rocket Development Division, Ordnance Research and Development Service.

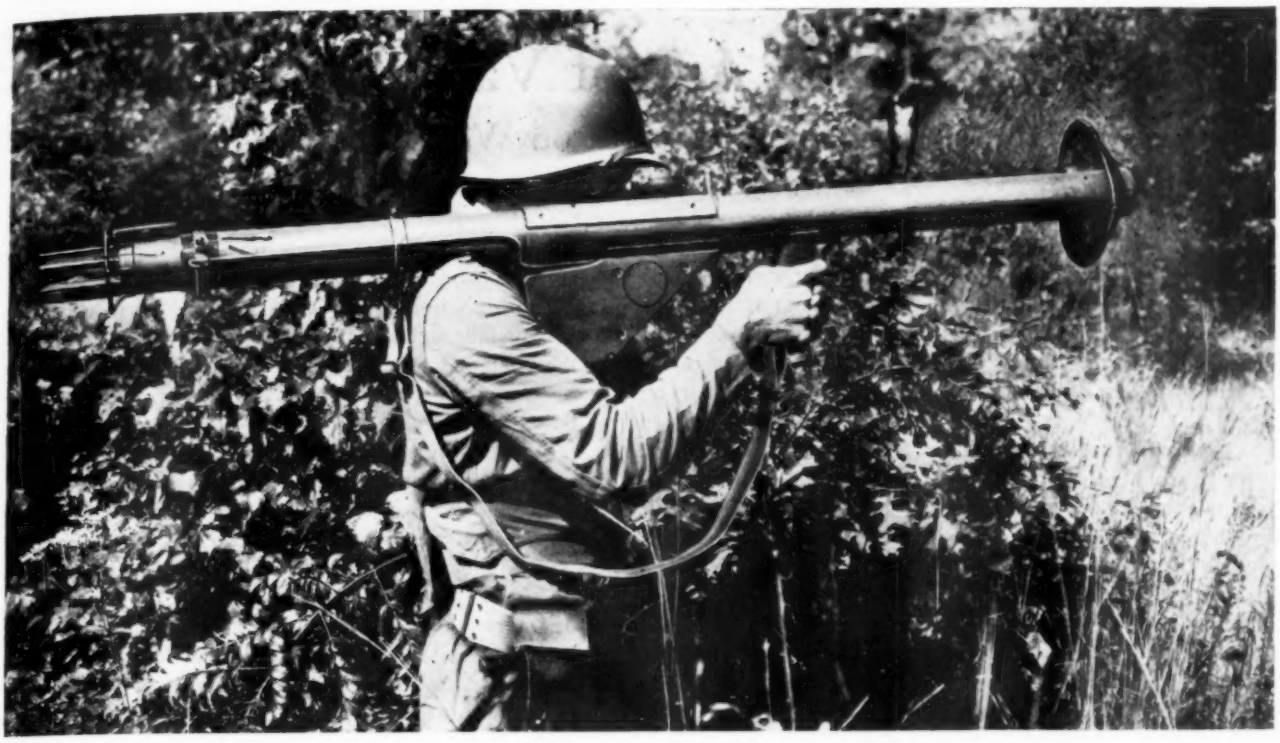


THE FIRST MODEL ROCKET GRENADE USED THE RIFLE BAYONET AS A LAUNCHER

neither Lieutenant Uhl nor myself knew much about rockets, Dr. Hickman's technical advice and his great patience in teaching us as we went along were major contributions to the eventual success of the 2.36-inch antitank rocket, M6.

Early in the spring of 1942, Lieut. Col. W. T. Moore, who had been one of the first to see possibilities in our gadget and whose encouragement was as welcome as it was needed, had produced for us, at Frankford Arsenal, the first launcher and the first factory-made conversion parts necessary to make a rocket out of the existing high-explosive antitank grenade, M10. As a result of his help and that of the N.D.R.C. through its group under Dr. Hickman, we had a few fairly respectable antitank rockets by May 1942. Captain (formerly Lieutenant) Uhl, dressed like the "Man from Mars," fired, rather fearfully, the first rocket from the shoulder at the test ground of N.D.R.C. Also in May, at Aberdeen Proving

CAPT. E. G. UHL, ORDNANCE DEPARTMENT, FIRING THE FIRST ROCKET GRENADE LAUNCHER T1, MAY 1942

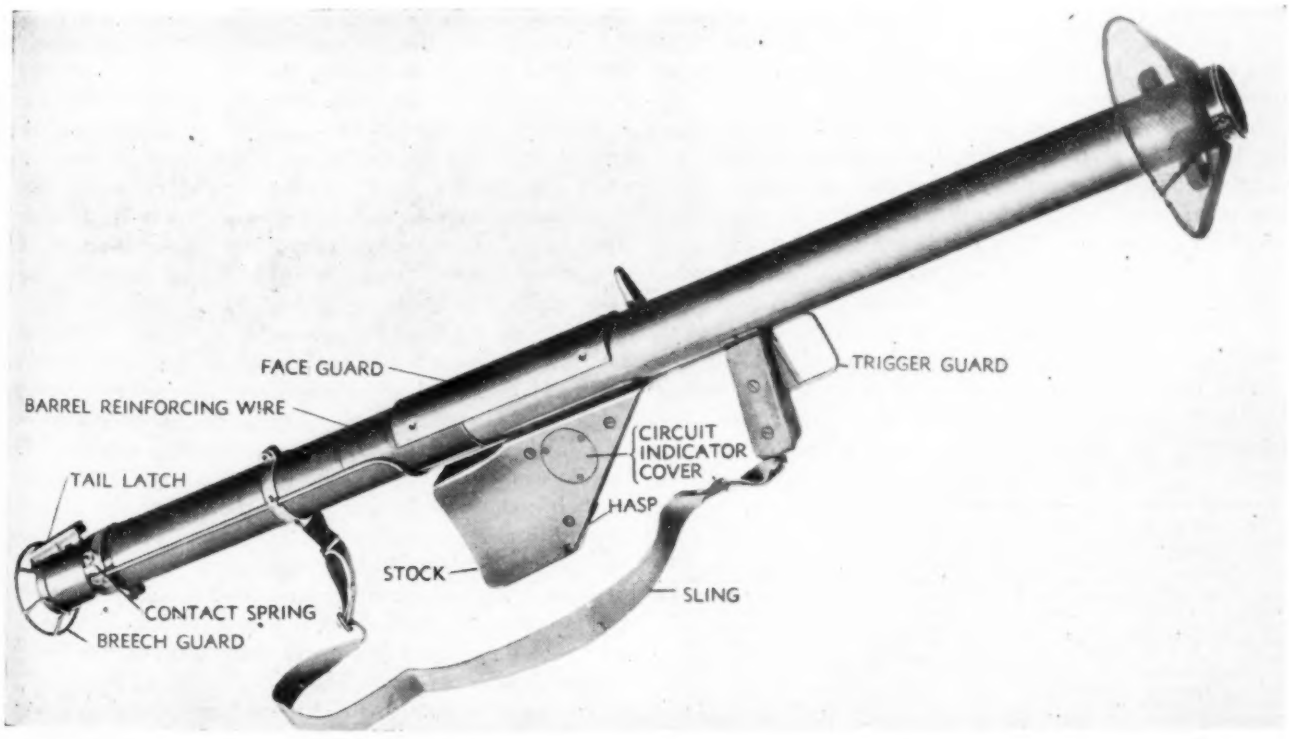


STANDING POSITION FOR FIRING THE MODERN BAZOOKA

Ground, Md., the experimental launcher and rockets with dummy heads were fired at a moving tank for Maj. Gen. G. M. Barnes, now chief of the Ordnance Research and Development Service, by Captain Uhl, the firing being impromptu, using a sight made on the spot from a piece of nail found on the ground. The results were good and General Barnes was impressed with the weapon's possibilities.

A number of demonstrations and tests were carried out during the summer, culminating in a large and formal one at Camp Sims, D. C., in June 1942. Here the real thing was shown in action against a medium tank before high officials of the War and Navy Departments, and the N.D.R.C.

The bazooka—formally known as the "Rocket, Antitank, 2.36-inch, M6," and "Launcher, Rocket, Antitank, M1"—is an example of a coöperatively developed weapon in which military, naval, and civilian agencies all played a part.



RIGHT SIDE VIEW OF THE BAZOOKA SHOWING PERTINENT FEATURES

The Age of Valor

The Influence of Armament on World History—II

Maj. Gen. J. F. C. Fuller

WHEN we look back upon Western warfare as it was before the introduction of firearms, of the differences we see, the one which most boldly stands out is the precedence of valor over cunning. The bravest and not the most crafty are the leaders of men, and it is their example rather than their skill which dominates battle. Fighting is a contest between man and man more so than between brain and brain. The spearman Achilles, and not Paris the archer, is the typical hero.

It is out of valor that European history rises; the spear and sword, and not, as in Asia, the bow and arrow, are its symbols. Psychologically, the *arme blanche* dominates the missile, and, as generations pass along their way, out of this dominance emerges Western idealism and finally realism, when Paris comes into his own.

On the one hand we have the religion of the sword, and on the other the politics of the bow: aristocracy and democracy, quality and quantity, castle and city, warrior and merchant, soldier and artisan, priest and politician, and many other antagonistic associations related to these two weapons through the moral values they instill.

Here, however, I intend to restrict myself to the influence of armament during the first half of this romantic age; that is, from the dawn of classical warfare to the sunset of the Western Roman Empire. The era opens with the palisaded village which, growing into the walled city, established an agricultural city state. Wars between these city communities were frequent, and, as the cities because of their walls were all but invulnerable, warfare in this age centered in the attack and defense of their food supplies. In fact, whichever side won literally garnered the harvest; therefore warfare was restricted to a few months each year, winter operations being unknown.

In this warfare armies were citizen levies, and, as training had to be of the simplest, therefore also tactics. The simplest of tactical formations is the hoplite phalanx—a deep line of armored heavy infantry equipped with shield and spear. In one compact body this line marched straight forward to engage. The attack was, therefore, in parallel order and was a test of endurance rather than of skill. Thus Greek fought Greek up to the battle of Marathon in 490 B.C., after which some semblance of tactics was developed.

This type of warfare was brought to its highest perfection by the Spartans who established their state on a military footing. By law the citizen soldier was required "to conquer or die."[1] To him war was a festival and battle a competition of courage. The place of honor was in the front rank, as Tyrtæus accentuates in one of his war songs: "Glorious indeed is death in the front rank of the combat, when the brave man falls fighting for his country."[2]

Each Spartan soldier was accompanied by a shield bearer, for his equipment weighed some seventy-two pounds. At the Battle of Plataea, in 479 B.C., the hoplite had seven helots, or serfs, who formed the rear ranks, making the depth of the phalanx eight in all. These men clubbed to death the enemy wounded[3] and attended to their masters should they be injured. In order to maintain line of battle, the hoplites kept step to the music of flute players.[4]

IN these ceremonial battles, tactics were concentrated in push of pikes and remained so until light troops were added to the phalanx. And had it not been for the religion of valor, there can be little doubt that this would have been done from the start. Yet, even so late as the Peloponnesian War (431-404 B.C.), except among the northern semi-Greek tribes, light troops were held in disdain.[5] Nevertheless, in 426 B.C., the Athenians under Demosthenes were severely defeated by Ætolian javelin men who, refusing to close, destroyed the phalanx from a distance.[6]

Through force of circumstances, however, this change was imminent, for early in the fourth century B.C. the Athenian General Iphicrates raised a true body of light infantry called peltasts and trained them for rapid movements. They wore a quilted or leather jerkin and carried shield, javelins, and sword. In 390 B.C. he proved their worth by all but annihilating a Spartan *mora* battalion.[7]

It is strange that the Athenians, a mercantile people, should have been so slow in creating this essential arm, for their cunning equaled their valor. Also, for long past they had maintained a highly efficient body of naval bowmen,[8] recruited from the second richest class—those not wealthy enough to keep a horse. During the Peloponnesian War these archers were so successfully employed in sea raids on Sparta that, according to Thucydides,[9] the Spartans, in order to meet them, "took the unusual step of raising 400 horse and a force of archers."

When, during the first two decades of the fifth century B.C., the Persian invasions of Greece were launched, first by Darius Hytaspis and secondly by Xerxes, the sole true cavalry soldiers in Greece were the Thessalians. They played no part in these wars, for they were completely outclassed by the Persian cavalry.[10] In spite of the mountainous nature of their country, it is strange that the Greeks should have been so backward in this arm; for twenty years earlier, in 511 B.C., the Spartans had experienced its value and to their cost, for they had been defeated by Thessalian horsemen not far from Athens.[11] According to Delbrück, "the whole course of the Persian Wars was determined by the Greek fear of Persian horsemen."[12]

The point to note in this brief summary of Greek warfare is that changes in armament are due solely to compulsion because, throughout, valor looked with disdain

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General Fuller is author of the following works, among others: "On Future Warfare," 1928; "India in Revolt," 1931; "Lectures on F. S. R. II," 1931; "Lectures on F. S. R. III (Operations between Mechanized Forces)," 1932; "War and Western Civilization, 1832-1932," 1932; "General Grant (A Biography for Young Americans)," 1932; "The Dragon's Teeth (A Study of War and Peace)," 1932; "Generalship, Its Diseases and Their Cure," 1933; "Grant and Lee (A Study in Personality and Generalship)," 1933; "Empire Unity and Defence," 1934; "The Army in My Time," 1935; "The First of the League Wars," 1936; "Memoirs of an Unconventional Soldier," 1937; "The Last of the Gentlemen's Wars," 1937; "Towards Armageddon," 1937; "The Decisive Battles," 1939; "Decisive Battles of the U. S. A.," 1942; "Machine Warfare," 1942; "Armored Warfare," 1943. Special correspondent, London *Daily Mail*, Italo-Abyssinian War. Major General, British Army, Retired. C. B., C. B. E., D. S. O. London, England.

[1] Reference notes are published in full on page 270.

upon inventiveness. Only in siege operations, which, during the earlier half of the classical age, improved little on what is recorded in the Book of Ezekiel,[13] do we find play given to imagination. Thus, at the siege of Plataea in 429 B.C., the Plataeans used fire arrows to burn the besiegers' engines;[14] at the siege of Delium a "gas attack" with sulphur fumes was made,[15] and, in 413 B.C., it would appear that the Syracusans defended their walls with liquid fire.[16]

Had the intelligence of the soldier not been so completely exorcised by valor, through a rational development of weapons and tactical organization Sparta might have changed the course of history.[17] Instead, this task was left to a small, obscure, and semibarbaric people under two kings of supreme intelligence and valor. These kings were Philip II of Macedon and his son Alexander the Great.

THOUGH it would appear that Dionysius I (430-367 B.C.), tyrant of Sicily, was the first among the Greeks to organize a combined fighting force, it was not until his contemporary, Philip II of Macedon (382-336 B.C.), a man of incomparably greater genius, set out to do the same that the first scientifically organized army appeared on the continent of Europe.

Denied quantity of suitable man power, Philip aimed at quality instead. His first step was to create a small *standing army* recruited from his own subjects. With it he was able to break away from the summer rule and so, chronologically at least, make war total by waging it all the year 'round. Also, this army was a totally new instrument, for though its arms differed little from those in common use, Philip scientifically arranged them into a combined fighting force. He placed the phalanx on a new tactical footing. From a shock arm he converted it into a holding force and in part or whole armed its hoplites with the *sarissa,* a pike probably thirteen feet in length [18] and, therefore, nearly twice as long as the heavy infantry spear. This not only gave the phalanx greater reach but multiplied the "volume" of spearheads it could bring to bear to its front. Therefore it vastly increased its power to resist and to press, though it made it less mobile.

The principles upon which the traditional phalanx was based were: (1) depth to give it weight, and (2) length to enable it to overlap its enemy and so outflank him. The second of these principles Philip scrapped as he clearly recognized the weaknesses in the phalangial order. These were: the difficulty of keeping in line on the move and the ease of confusion—deadliest enemy of the phalanx;[19] the impossibility of rapidly forming front to a flank, or to pursue in line;[20] the vulnerability of the flanks to attack, more especially by cavalry.

To remedy these weaknesses, Philip hinged his heavy cavalry onto the right of the phalanx, making it his offensive or shock wing. The bulk of his auxiliary cavalry he linked to its left as a defensive wing. In between the heavy cavalry and the right of the phalanx he interposed a new body of troops, the *hypaspists,* to protect the left flank of the heavy cavalry when it advanced, and for a similar purpose he drew up his light troops on the right of the cavalry. The whole order was, therefore, both defensive and offensive. Whereas the wings were highly mobile, the center was as firm as a rock.

His heavy cavalry, the companions or *hetæra* (followers), was recruited from the Macedonian aristocracy and armed with the sword and *xyston,* a short cavalry spear used both for hurling and thrusting. The troopers carried a shield and wore heavy armor. They were the first real heavy cavalry in Europe. Also Philip raised a body of lancers *(sarissaphori),* armed with a light sarissa. They were the forerunners of the cataphract cavalry of a later age, and the distant parent of the medieval knights. His auxiliary cavalry was mainly recruited in Thessaly, and was armed and equipped like the companion cavalry.

The hypaspists—named after *aspis,* the great shield they carried—formed a standing corps of household infantry guards. They were equipped much like the old hoplites and trained for close combat. They were particularly useful in mountain warfare, for forcing a river passage, and supporting cavalry.

The light troops were slingers, archers, and javelin men. Besides, Philip formed a fully organized siege train of arrow-firing catapults, stone throwers, and battering rams—the latter essential instruments in an age of walled cities.

Looked upon as a whole, Philip's army was a moving fortress. The purpose of the phalanx was to form an impenetrable defensive front until the heavy cavalry issued forth. In turn, the cavalry's purpose was, by shock action, to disrupt the enemy's line and, normally, not to attack cavalry. This was the duty of the auxiliary horse, as well as to attack the enemy in flank. Such was the formidable instrument of war his son, Alexander (356-323 B.C.), inherited, and with it he conquered the known world of his day, thereby changing the course of history.

WITH consummate genius Alexander carried out this task in twelve crowded years. As a statesman and a general he towered above his age, and today still stands in a unique position. He won every battle he fought and took every city he besieged. Both in summer and winter he marched in whatever direction he desired, whether over plains, mountains, or deserts. He knew how to exploit victory politically and strategically and how to combine strategy and policy. He was on the whole a chivalrous combatant and to his men the prince of valor and a master of craft. Yet, without the army he inherited, he could have accomplished nothing. For the first time in history, a superb armament was mated to a supreme genius, and together they surmounted every obstacle. Droysen called his army "the first strategic unit known," and he adds "it carried in itself the certainty of victory."[21]

In the spring of 334 B.C., at the head of 30,000 foot soldiers and 5,000 cavalry,[22] Alexander invaded Asia, and thence onward to the defeat of Darius at Gaugamela in 331 B.C. From right to left his normal order of battle was as follows: light infantry (javelin men, slingers, and bowmen), companion cavalry, hypaspists, phalanx, confederate cavalry, and Thessalian cavalry. Cavalry was his dominant arm, and in battle he invariably led his companions in person. Of the twenty-two battles he fought, Denison [23] has estimated that fifteen were decided by cavalry. And, as a cavalry general, Dodge has written of him: "Had Alexander not been one of the world's great captains, he would have been the typical *beau sabreur* of the world's history."[24]

Second only to his cavalry came the hypaspists and light troops. As regards the latter, Professor Tarn points out that before his day they had never been used seriously, and after it "we seldom hear of their doing anything particular in battle."[25] Among them the Cretan archers were held in highest esteem.

In battle, Alexander's phalanx, sixteen ranks deep, played

a subordinate yet important part. Its mission was to maintain the cohesion of the army as a whole, and for its own defense it relied on the Thessalian and confederate cavalry. By lengthening the line it protected the rear of the right wing against attack, and its holding power enabled that wing to operate with calm and assurance. As Rüstow and Köchly point out: "Alexander would never have dreamed of fighting with the phalanx only . . . it is the shade in the picture of a battle fought by Alexander and the right wing is the light."[26]

THOUGH the catapult was essentially a siege piece, on several occasions Alexander used it as field artillery. Thus, in his early Illyrian campaign, he covered the retreat of his men over a river by "all sorts of projectiles from his engines."[27] At the crossing of the river Jaxartes (Syr Daria) he reversed this procedure,[28] and when storming Aornus (Pir-Sar) he employed his catapults as mountain artillery.[29] In sieges his engines were used with great effect, notably so at Tyre, one of the most remarkable sieges in history. Further, when in India, he organized a ponton train.[30]

His system of war was novel because it was common sense. He, it would appear, first discovered the principle "March divided and fight united." Also, he was the first general in Western history to press the pursuit after a great battle, and when occasion demanded he moved with astonishing speed. Thus, in his pursuit of Darius, he marched 400 miles at an average of 36 miles a day including halts, and in the relief of Maracanda (Samarkand) his column advanced 135 miles in little over 72 hours. To defeat his enemy's army and not merely his cavalry, as later became customary, was always his aim. Once he decided to attack, he never abandoned the offensive until his enemy was routed or destroyed. His campaigns were *Blitzkriegs*.

Though the army he bequeathed to his successors, the Diadochi, was organized to police his empire, in their hands it was employed to disrupt it. Wars were no longer fought against undisciplined barbarians but between similarly organized armies under equal leadership. Though technical improvements were introduced, tactics and morale degenerated. More and more was reliance placed in mercenaries who could be bought and sold; therefore gold began to become a decisive tactical factor. The sarissa was considerably lengthened, and the light-armed troops were cut down with the result that when, in 280 B.C., the Gauls inundated Thrace and Macedonia, the Greeks were unable to face them. Further, an increasing reliance was placed on cavalry, but as often as not unrelated to the other arms. Field fortifications crept onto the battlefields, but the greatest innovation of all was the employment of elephants as a shock arm. This animal, it may be said, established the tactical problem of the age; but how elephants were combined with infantry and cavalry is not known.

Alexander, for the first time, faced the war elephant at the battle of Gaugamela and then again on the Hydaspes (Jhelum) in 327 B.C. Fearing that his horses would not face them, he decided to turn Porus's right flank by crossing the river.[32] It would appear that he judged them at their doubtful worth, for he never employed them in war. Not so his successors, who used them extensively. So important were they considered to be by Seleucus that he ceded the eastern provinces of Alexander's empire to Chandragupta for a herd of 500 and with them won the decisive battle of Ipsus in 302 B.C.[33]

Generally speaking, their terrors were soon overcome by experienced troops, but frequently, when used for the first time, their moral effect was deadly. For instance, it was with his elephants that Antiochus I first checked the Gauls. A saying of his has been recorded as follows: "I am ashamed to think that we owe our safety to these sixteen animals."[34] At the battle of Raphia, in 217 B.C., Antiochus III's Indian elephants were matched against Ptolemy IV's African and beat them.[35] Their last serious employment[36] was at Magnesia in 190 B.C., where Antiochus's elephants, becoming unmanageable, threw his army into such confusion as to lead to his defeat. Much the same had happened to Hannibal at Zama in 202 B.C.

Antielephant tactics were also developed. Instruments were invented to injure their feet. The most extraordinary device was adopted by the Megareans: they drove against Antigonus's elephants pigs smeared with pitch and set alight. In order to counteract this, Antigonus ordered his Indian mahouts always to keep swine among the elephants so as to accustom them to this "device."[37]

As tactics declined in field warfare, so also in siege, and in spite of technical improvements. It was lack of siegecraft which mainly accounted for this. Among the successors, Demetrius alone acquired the reputation of a city taker; yet, in 305 B.C., tactically he failed in his greatest siege—that of Rhodes.[38] During it the Rhodians fired off 800 flame carriers which burnt Demetrius's armored towers. At the siege of Thebes, the tower which Demetrius built was so heavy that it took two months to move it two furlongs.[39]

Listening devices for detecting mining and countermining had been used as early as the fourth century B.C.[40] Polybius describes one employed by the Ætolians in the siege of Ambracia in 189 B.C. It consisted in a row of thin metal vessels sensitive to the slightest vibration.[41]

THE wars of this period had a remarkable influence on history. The vast hoards of gold and silver seized by Alexander in Persia were, in the wars of the Diadochi, set in circulation to fertilize a new civilization, known as the Hellenistic, the intellectual and commercial center of which was Alexandria. Gold power was transformed through leisure into brain power, and, as wars were unceasing, brain power turned toward military mechanization.

So it came about that, in the century following the death of Alexander, the progress in mechanics was unrivaled for nearly 2,000 years. We still have accounts of the engines invented by Heron, 284-221 B.C., Philo, about 200 B.C., and Agesistratus, of the same date. The last-mentioned informs us that the artillery of his day could fire missiles up to a range of 800 yards. Dionysius, an Alexandrian engineer, invented a *polybolos*, a "machine gun" which enabled a succession of arrows to be fired from a magazine.[42] And Ctesibius, another engineer of the same city, discovered a means of gearing to the bow arms of catapults pistons working in "carefully wrought cylinders" which were filled with compressed air.[43]

At the battle of Mantinea, 207 B.C., Machanidas, the tyrant of Sparta, advanced with a large number of "carts carrying quantities of field artillery and bolts for the catapults";[44] but Philopœmen, the Achæan general, seeing that the enemy's plan was "by pouring volleys from the catapults into his flanks to throw the ranks into confusion," brought forward his cavalry and charged the engines.

Thus valor was supplemented by technique, when a peo-

ple arose in the West who knew better than the Hellenistic Greeks how to combine the two. This people emerged from out the city of Rome to reap in full the cultural crop sown by Alexander and his successors.

The Romans were a highly patriotic people, eager to subordinate themselves to the state. Those who belonged to one of the original family clans were burgesses of Rome, and their most important duty was military service, for they alone had the right to bear arms. They formed the "spear-armed body of warriors upon whom the blessing of Mars was invoked." And as service in war was the sole road to civic honors, these men of valor, as a military caste, shaped the character of the Roman people. Of them, Livy wrote: "Such is the temper of the Roman nation that it knows not how to remain at peace, vanquished though it be." To this war-loving people, life was battle and heroism—religion.

GENERAL FULLER herewith presents the second in a series of six articles on the influence of armament upon world history which he is writing for ARMY ORDNANCE. *A distinguished British soldier, tactician, author, and historian, General Fuller is well qualified to make this study of the ordnance of the past and present and to evaluate the effect of such arms development on the military and social trends of the future.*

In his first installment of this series (ARMY ORDNANCE, *July-August 1944, Vol. XXVII, No. 145, p. 73), General Fuller gave a résumé of the use of arms and armor through the centuries down to the present time. In this article he treats of the influence of armament from the dawn of classical warfare to the fall of the Western Roman Empire.*

Future installments to be published in these pages will bring the story of the world's weapons through successive eras up to the present day.—EDITOR.

In the Roman Army the military unit was the legion or "gathering of the clans"; originally it was a phalanx armed in the old Doric style. At an early date it consisted of 4,200 men in 8 ranks. The first six were hoplites and the last two *velites*—the light-armed. On its flanks stood two squadrons of cavalry, each 150 strong. Like the Greek phalanx, its tactical principle was shock. It had no reserves, and pursuit was difficult.

This primitive organization was completely revolutionized in the fourth century B.C. by, as some suppose, Marcus Furius Camillus, the most celebrated Roman general of the Gallic Wars (391-360 B.C.). This seems probable, for in these wars the Romans were faced by a new type of army, the Celtic sword phalanx.

THE phalangial legion was now divided into three separate divisions ordered in depth. These divisions were known as *hastati, principes,* and *triarii*. Their men were paid soldiers and allotted to their divisions according to service, the hastati being the youngest soldiers and the triarii veterans. All these divisions were organized in companies (*manipuli*) the first 2 of 120 men each and the third of 60. A cohort consisted of one maniple of each class as well as 120 velites and a squadron (*turma*) of cavalry 30 strong—in all, 450 soldiers. Ten cohorts made up a legion. In battle order the maniples were drawn up checkerwise, so that those of the second division covered the intervals in the front of the first and the third those of the second. The cavalry, ten *turmae,* formed a wing (*ala*).

The armament of the legion is fully described by Polybius in sections 22-25 of his Second Book. The velites carried a sword, spear, and target (*parma*) three feet in diameter. The spear was for throwing and had so slender a point that, once cast, it bent and became useless in the hands of the enemy.

The hastati carried a large shield (*scutum*), semicylindrical in shape. It was 2 feet, 6 inches wide and 4 feet long and was made of 2 layers of wood glued together, covered with hide and bound with iron. These soldiers were armed with a short thrusting sword (*gladius*) and two javelins (*pila*) and wore a brass helmet and greaves as well as a brass plate on their breasts (*pectorale*) or, if they could afford it, a cuirass (*lorica*). The principes and triarii were armed and armored in like manner, except that instead of pila they carried long spears (*hastae*).

The cavalry, it would seem, were completely neglected, for even at the opening of the Punic Wars they had no armor, their shields being of leather and their swords and lances mediocre. Normally, they preferred to fight on foot.

Looking back on the whole picture, Vegetius wrote in the fourth century A.D.: "We see that the Roman people have conquered the world by nothing other than drill in arms,"[45] and Josephus describes the Roman drills as bloodless battles and their battles as bloody drills.

Tactically, these changes were radical: close and distant fighting were combined, a reserve came into being, and the offensive and defensive were closely knit together. Considering the manipular legion Mommsen writes:

"The Roman combination of the heavy javelin with the sword produced results similar . . . to those attained in modern warfare by the introduction of bayonet and muskets —the volley of javelins prepared the way for the sword encounters exactly in the same way as a volley of musketry now precedes a charge with the bayonet. Lastly, the thorough system of encampment allowed the Romans to combine the advantages of defensive and offensive war and to decline or give battle according to circumstances. In the latter case it enabled them to fight under the ramparts of their camp just as under the walls of a fortress. "The Roman," says a Roman proverb, "conquers by sitting still."[46]

WITH this formidable fighting machine Rome set out to conquer first Italy, secondly Carthage, and thirdly Macedonia. The first she accomplished in the three Samnite Wars (343-290 B.C.) and the war with Pyrrhus, king of Epirus (280-275 B.C.); the second in the first two Punic Wars (264-241 and 218-201 B.C.), and the third in the three Macedonian Wars (214-168 B.C.). She utterly destroyed Carthage in 146 B.C.

In the war against Pyrrhus, for the first time the legion met the Greek phalanx and in the end defeated it. Yet, as Professor Tarn points out: "Given its own conditions—a formal battle on level ground, with an Alexander or a Pyrrhus to guard its flanks—the later phalanx would have defeated the legions or anything else; but a formation which can only fight under special conditions had ceased to be of much use."[47]

The Carthaginian army was also based on the phalangial order, and once the Romans had, during the First Punic War, gained command of the sea—an amazing effort—in the Second they were called upon to face this army under Hannibal. That this great captain accomplished what he did is in itself remarkable, seeing that his army was mainly composed of mercenaries drawn from many races, all armed with their own weapons—swords, spears, flails, bows, etc.—combined in no scientific arrangement. His most useful infantry were the Balacric slingers who carried two slings, one for long-range and the other for short-range fire. His decisive arm was, however, his cavalry, to which, more so than to any other arm, he owed his great victory of Cannae in 216 B.C.

After this battle Hannibal sought to entice the Romans to fight in open country where he could employ his cavalry to advantage. But they had learned their lesson and kept to the hills. With discernment Polybius remarks: "I think the reason of the strategy adopted by the two sides respectively was that they both had seen that Hannibal's cavalry was the main cause of the Carthaginian victory and Roman defeat."[48]

The Carthaginian order of battle was normally as follows: In the center the heavy infantry—Carthaginian, Liby-Phœnician, Spanish, or Gallic—with the Balacric slingers and sometimes elephants in front. On its flanks were posted heavy cavalry and swarms of Numidian horsemen. It was only when commanded by a genius, such as Hamilcar or Hannibal, that so heterogeneous a gathering could be forged into a reliable instrument.

FOR sixteen years the Romans fought this motley army, and though their valor was unexcelled and their staunchness unequaled, it was not until Scipio Africanus raised and armed a body of cavalry worthy of the legion that he finally defeated Hannibal at Zama in 202 B.C. This defeat broke the Carthaginian power and reduced Carthage to a defenseless mercantile town.

The words both of Livy and Polybius have for all time summed up the influence and results of this decisive battle. The first, as he set forth to describe it, wrote: "Before tomorrow night they would know whether Rome or Carthage should give laws to the world; and that neither Africa nor Italy but the whole world would be the prize of victory."[49] And the second: "To the Carthaginians it was a struggle for their own lives and the sovereignty of Libya; to the Romans for universal dominion and supremacy."[50]

Power, as always, soon corrupted the Romans, and as wealth increased the old burgess army rapidly changed into a long-service professional one recruited from the poorer classes and from the provinces. The ancient love of country rapidly declined, and in its place crept in a spirit of avariciousness. Conquests were no longer made for the security and glory of Rome, but instead to enrich the plutocrats and increase the pay of the soldiers.

About 104 B.C., Marius (157-86 B.C.) abolished the property qualification for recruiting, when the legions became wholly proletariat and professional. Further, in order to lessen the danger inherent in the many intervals in the front of the manipular system, he reorganized the legion in three lines of cohorts, each cohort consisting of five maniples. The tactical unit was thus increased from 120 to 600 soldiers; as there were 10 cohorts in the legion—normally 4 in the first line, 3 cohorts in the second, and 3 in the third line—the strength of the legion was raised from 4,200 to 6,000. The legionary cavalry was abolished, its place being taken by foreign cavalry (*auxilia*). By degrees, the intervals between the cohorts were diminished, until, to all intents and purposes, the phalangial order was reintroduced. As the class of soldier deteriorated, pay was increased. Avarice replaced honor. Armies more and more belonged to the chiefs who paid them; yet as the rank and file degenerated the urge toward good leadership increased. Thus, the old militia system gave way to the professional army, and, as we shall shortly see, to a highly mechanized force; engineering, the art of fortification and siegecraft, developing by leaps and bounds.

Such armies demanded highly educated and skillful generals, and, when these were forthcoming, success was assured. Of Julius Cæsar's army Mommsen says: "Perhaps there never was an army which was more perfectly what an army ought to be." Nevertheless, it carried within it the seeds of its own ruin, and with it the ruin of the Empire to which it belonged.

The exact structure of the legion in Cæsar's days is unknown, but probably it was much as Marius had left it. Its arms and armor would appear to have been little changed, except that light troops, slingers and bowmen, were increased. The most remarkable innovations were the increase in cavalry, artillery, and engineers. The first was largely brought about by contact with the Numidians and other mounted foreigners; the second and third were due to wars with the Greeks and Carthaginians as well as to contact with the engineers of Alexandria. Here I can only give a few examples of this radical change toward machine fighting, yet they are sufficient to show what was taking place.

In 53 B.C., during the siege of Avaricum (Bourges) Cæsar apparently made use of some form of quick-firing engine.[51] In his campaign against the Bellovaci (a tribe around Beauvais) in 51 B.C., we find him using veritable bombardments of projectiles in the open field. Having built a bridge over a morass he "led his army across and soon reached the plain on the top of the hill, which was fortified on either side by a steep ascent." From this position "having there drawn up his army in order of battle he marched to the furthest hill, from which he could, with his engines, shower darts upon the thickest of the enemy."[52]

We read of a similar operation when he attempted to hem in Pompey at Dyrrachium (Durazzo); for his ninth legion having gained a hill began to fortify it. Whereupon Pompey seized a neighboring hill and brought such concentrated artillery fire to bear on these men that they had to abandon the work and withdraw.[53]

We know that Antony, in his expedition against the Parthians, had a siege train of 300 wagons.[54] The smaller fieldpieces were transported in carriages called *carrobalistae* some of which may be seen among the sculptures on Trajan's Column erected in Rome between 105-113 A.D. This field artillery was probably in use a hundred years earlier. Mules were harnessed to these vehicles, and the pieces carried on them could be discharged over the heads of the animals. According to Vegetius,[55] every cohort was equipped with one catapult, and every century with one carrobalista, eleven soldiers being required to work this engine. Therefore the legion possessed an artillery train of 60 carrobalistae and 10 catapults—that is to say, 60 field guns and 10 howitzers. This corresponds closely to the number of guns in a modern infantry division. But in a modern division

the number of guns to infantry is about six per thousand, whereas in the legion it was approximately double that amount.

HAND in hand with mechanization went progress in fortification and siege work, and in these branches of the art of war Cæsar is without a rival. For instance, in 52 B.C. at the siege of Alesia (Auxois), it has been calculated that his men shifted 2,000,000 cubic meters of earth from the trenches they dug,[56] and, 4 years later, at the siege of Dyrrachium, it must have been much the same. At the siege of Massilia (Marseilles) in 49 B.C., all manner of engines were employed, and the largest trench of this period was the one Crassus dug from sea to sea across the toe of Italy. It was 15 feet deep, 15 broad, and 34 miles long.[57]

With reference to engineering, it should never be overlooked that the Romans of Cæsar's day owed as much if not more to their entrenched camps and roads as to their legions. Their camps rendered them all but unattackable, and their roads enabled them to swoop down on an enemy at unexpected speed. Nevertheless, though mechanization of war saved lives and made soldiering easier, it cramped initiative and exorcised valor. Two consequences arose from this. The first was the imperative necessity for high-grade generalship, and the second was the barbarization of war.

Cæsar was a genius, therefore he could handle his fighting machine superbly well. His conduct of war was scientific: he always aimed at the decisive point, he turned his entrenched camps into mobile fortresses, he struck at his enemy's line of communications, and his plans were so subtle that he unfailingly kept his antagonists guessing. Yet he was inordinately brutal: his campaigns were largely massacres and his battles ferocious killings.

The age of valor, and with it chivalry, was withering. Polybius noticed this, for in his day, with reference to the destruction of cities and wasting of the lands, he pointed out that, in the century following Alexander, Greek warfare was far humaner than under the Romans. Further, he comments, and with no uncommon wisdom: "To destroy that for which a war is undertaken seems an act of madness, and madness of a very violent sort."[58]

Once the destructive civil wars which heralded the final collapse of the Roman Republic had spent themselves, Augustus (63 B.C.-14 A.D.) the first of the Emperors, reorganized the army in three classes: legions, auxilia, and Prætorian Guard. The first were recruited from Roman citizens, though by now millions of them were foreigners; the second were composed of enlisted noncitizens, and in the main were bowmen and cavalry; the third was a body of household troops, in all 10 cohorts, each 1,000 strong. After 70 A.D., recruiting in Italy practically ceased; nevertheless service in the legions was still confined to citizen rank. In short, what Augustus established was a military state with himself as commander in chief. Then onward the soldier's oath of loyalty was to the Emperor, and not to his general.

The problem which faced Augustus and his successors until the year 250 was imperial security. Therefore powerful field armies were no longer required but rather frontier garrisons. To meet this change he placed the army on a footing of 25 legions and, probably, an equal if not superior number of auxilia, in all some 380,000 troops. These he distributed in twenty-five frontier groups, each of which was based on a strong military center called a *castellum*. Further, the frontiers were fortified and these centers linked up by roads. As the aim of the legions was now to maintain peace and not to make war, the old Roman valor, whether based on patriotism or plunder, deteriorated rapidly.

This change in moral values had two effects. The first was to breed pacifism through loss of fear, and the second to establish a most pernicious form of militarism through the dependence of the Emperor on the army. The social conditions which the first led to are well described by Petronius Arbiter, a writer of the Neronian age, in his "Satyricon," of which the following extract is a sample:

"Greed of money . . . has produced this revolution. . . We, engrossed in wine and women, have not the courage to master the arts already discovered; depreciators of antiquity, vice is the only thing we learn and teach. . . Do not wonder then if painting is decayed, since in all eyes, both gods' and men's, a lump of gold is a more beautiful thing than ever was produced by those crazy Greeks, Apelles and Phidias."[59]

By 175, the dry rot of peace had so eaten into Roman valor that the Greek sophist, Ælius Aristides, with approbation described the conditions of his day as follows:

"Now the whole world keeps holiday and laying aside its ancient dress of steel has turned in freedom to adornment and all delights. The cities have abandoned their old quarrels, and are occupied by a single rivalry, each ambitious to be more pleasant and beautiful. Everywhere are playgrounds, fountains, arcades, temples, workshops, schools. To use a metaphor from medicine, the world, sick from creation, has recovered its health. . . To be safe, it is enough to be a Roman . . ."[60]

The direct effect of this pacifism on the legions, and more particularly on the Prætorian Guard, was that, as fewer and fewer citizens would enlist, more and more had barbarians outside the Empire to be recruited, and they were not men of peace but men of war. Their wholesale enlistment rendered the army un-Roman, yet it was they who made and unmade Emperors. Thus it came about that pacifism bred militarism and the old Roman discipline disappeared.

AS this degeneration was advancing, in 250 the Allemani and Franks broke into France. Thus were initiated the barbaric invasions. As the frontier defenses and garrisons (250,000 infantry and 110,000 cavalry) could no longer be relied on, Diocletian (284-305) created a field army of 150,000 foot and 46,000 horse as a central reserve. Apparently for the sake of mobility the legion was reduced to a unit 1,000 strong, and archers, slingers, and war engines were multiplied.

Nevertheless, the Germanic tribes continued to pour in. For a space they were held back by Valentinian (364-375), who shortly after he was elected Emperor appointed his brother Valens as co-Emperor to rule the eastern provinces and by doing so unwittingly opened the Danubian door to the great Gothic invasion. When Valens was informed that the Goths had asked to be allowed to cross the Danube, he gave them permission to do so, for in them he saw a splendid recruiting ground for his army. But, once over the river, they were so badly treated that they rose in revolt.

Professor Oman describes the armament of the Germanic tribes as follows: "The rank and file bore iron-bound bucklers, pikes, the short stabbing sword (*scramasax*), as well as the long cutting sword (*spatha*) and among some races the deadly *fransisca,* or battle-ax which, whether thrown or wielded, would penetrate Roman armor and split the Roman shield."[61]

When Thrace was ravaged, Valens was at Antioch. At once he hastened back to Constantinople and appointed Sebastianus, an able soldier, to command against Fridigern and his Goths. Zosimus tells us that "observing the indolence and effeminacy both of the tribunes and soldiers," Sebastianus picked out 2,000 of the best of them, for "he knew well the difficulty of commanding a multitude of ill-disciplined, dissolute men, and that a small number might more easily be reclaimed from their effeminacy."[62] Having trained them he harried his enemy.

From Constantinople, Valens at the head of a large army moved to Adrianople, and was advised by Sebastianus to remain there under shelter of its walls. This advice he set aside, and moving on, toward noon on August 9, 378, he came in sight of the Gothic laager. While attacking it, his army was charged by Fridigern's horse, under Alatheus and Saphrax, who descended on it "from the mountains like a thunderbolt."[63] Driven into an unmanageable mass, it was utterly destroyed: 40,000 men are said to have perished.

NEVER before had the Romans suffered so decisive a defeat, not even at Cannae, for then and long after their valor was indestructible. "The Empire rocked on its foundations," writes Prof. Martin Bang. "Sheer panic fell upon all that bore the name of Rome. The power and glory of the Empire seemed stamped into the dust by the barbarian hordes. . . . The battle of Hadrianople introduces the last act of the great drama, the most pregnant with consequences which the history of the world has ever seen."[69] It showed that valor remained the first requisite in shock warfare.

Hitherto, under the Romans, infantry had dominated, and when they relied upon shock weapons they had little to fear from cavalry, as long as they maintained their order. The increasing use of missiles, however, carried with it an unavoidable loosening and disordering of the ranks. The old shield-wall began to be replaced by a firing line, and as archers and slingers cannot easily combine shield with bow or sling, and as the range of these weapons is strictly limited, and as the bow is at a discount in wet weather, opportunity for the cavalry charge steadily increased. Therefore the problem was how to combine firepower with security against cavalry. As we shall see in another article, this problem was not solved until the mid-nineteenth century.

References

[1] Herodotus, VII, 104. [2] Quoted from "Geschichte des Griechischen Kriegswesens etc.", Rüstow and Köchly, Book I, p. 49 (1852). [3] Pausanias, IV, 8, 7. [4] Thucydides, V, 70. [5] *Id.*, III, 94. [6] *Id.*, III, 98. Xenophon (444-355 B.C.) clearly appreciated the value of light troops. In the Cyropædia he makes Cyrus say: "I will post the javelin men behind the cuirassiers and the archers behind them: it would be absurd to place in the van troops who admit that they are not made for hand-to-hand fighting; but with the cuirassiers thrown in front of them they will stand firm enough and harass the enemy over the heads of our own men with their arrows and their darts" (Cyropædia, VI, 3, 24). [7] Xenophon, "The Hellenics," IV, 5, 14-16. [8] Polyaenus, VI, 46. [9] Thucydides, IV, 55. [10] Herodotus, VII, 196. [11] *Id.*, V, 63. [12] "Geschichte der Kriegskunst," Hans Delbrüch, Part III, p. 92 (1900). [13] *Ezekiel*, IV, 1-2. Born about 622 B.C. [14] Thucydides, II, 75. [15] *Id.*, IV, 100. At the siege of Ambracia, in 189 B.C., the Ætolians smoked out the besieging Romans by burning feathers in their countermines. An interesting description of the instrument used is given by Polybius, XXI, 28. [16] *Id.*, VII, 43. A very old device pictured in Assyrian bas-reliefs in the British Museum. [17] According to Plutarch, Lycurgus (ninth century B.C.)—the reputed founder of the Spartan constitution—"was rigid and aristocratical, banishing all the base and mechanic arts to the company of servants and strangers, and allowing the true citizens no implements but the spear and shield, the trade of war only, and the service of Mars. . . Every sort of money-making was forbid them as freemen; and to make them thoroughly so and keep them so their whole lives, every conceivable concern with money was handed over, with the cooking and the waiting at table, to slaves and helots." [18] This is W. W. Tarn's reckoning: see "Hellenistic Military and Naval Developments," pp. 14-16 (1930). Delbrück (Part I, p. 143) is of opinion "that the front of the two advanced ranks of the phalanx carried, as usual, the handy 'hoplite' spear, and that the rear ranks only were provided with the long spear." [19] As Delbrück points out, the same applied to eighteenth-century armies. In 1757 the Emperor Francis I wrote on the Prussian method of warfare: "It was but seldom that they secured important advantages as the result of a victory. The reason was that they feared nothing so much as to throw their ranks into confusion, for which reason they avoided a hasty pursuit" (Part I, p. 31). [20] Thucydides, V, 73. [21] "Geschichte Alexanders des Grossen," Joh. Gust. Droysen, p. 93 (1833). [22] Arrian, "Anabasis of Alexander," I, XI. [23] "History of Cavalry," p. 33 (1877). [24] "Alexander," Vol. II, p. 661 (1890). [25] "Hellenistic Military and Naval Developments," p. 19. [26] "Geschichte des Griechischen Kriegswesen etc.", Book IV, p. 268. [27] Arrian, I, VI. [28] *Id.*, IV, IV. [29] *Id.*, IV, XXX. [30] Diodorus, XVII, 86, 3. See also Arrian, V, VII. [31] Antigonus and his son Demetrius Poliocetes, Antipater and his son Cassander, Seleucus, Ptolemy, Eumenes, and Lysimachus. [32] Arrian, V, X. [33] See Plutarch's "Demetrius." [34] Quoted by Delbrück, p. 202. [35] Polybius, V, 85-86. [36] The last recorded employment was at Thapsus in 46 B.C. [37] Polyaenus, IV, 3, 6. [38] Plutarch's "Demetrius"; also Diodorus, XX, 91. [39] Plutarch's "Demetrius." [40] Aeneas Tacticus, 37. [41] Polybius, XXI, 28. [42] "Mathematici Veteres," Melchisedech Thévenot, pp. 73-74 (1693). [43] Philo, IV, 78, 33. [44] Polybius, XI, 11. [45] Vegetius, I, 1. [46] "The History of Rome," Theodor Mommsen (Everyman's Edition, 1911), Vol. I, p. 436. [47] "Hellenistic Military and Naval Developments," W. W. Tarn, p. 29 (1930). [48] Polybius, IX, 3. [49] Livy, XXX, 32. [50] Polybius, XV, 9. [51] Cæsar, "De Bello Gallico," VII, 25. [52] *Ibid.*, VIII, 14. [53] Cæsar, "The Civil War," III, 45. [54] Plutarch's "Antony." [55] Vegetius, II, 25. [56] *Revue des Deux Mondes*, May 1, 1858, p. 113. [57] Plutarch's "Crassus." [58] Polybius, XVIII, 3. [59] "Satyricon" (Bohn's Edition, 1854), Chap. XI, pp. 287-288. On May 26, 1944, when a question of preventing the U.S.A. from buying up British art treasures was raised in the House of Commons, Mr. Maclaren stated: "So disposed was the mentality of the nation in recent years that the people did not care a damn for art. They preferred to go twice a night to see muck from Hollywood." [60] Aristides, "Panegyric of Rome" (tr. R. W. Livingstone). [61] "A History of the Art of War," p. 12 (1898). [62] Zosimus, IV. [63] Ammianus Marcellinus, XXXI, XII, 13. [64] "The Cambridge Medieval History," Vol. I, p. 217.

The Jeep in Action

Some Adventures of the Army's Ubiquitous Vehicle

Maj. E. P. Hogan

ONE of the most important and most indispensable pieces of equipment developed for World War II is the "truck, ¼-ton, 4x4," labeled by the American public and known the world over as the "jeep." Few will deny this. In the years since 1940 when the first pilot model of this vehicle was built to Army specifications by the American Bantam Car Company, presidents, kings, generals, and privates have ridden jeeps in the far corners of the earth. For stamina, battlefield maneuverability, and general utility, there has never been anything like it in motor transportation's half-century history.

The jeep was planned and designed over a period of years in countless hours of conferences to meet the requirements of all arms and services, particularly the Infantry and Cavalry who wanted a small, tough, agile car. It was developed and put into production by the Quartermaster Corps in close coöperation with civilian industry. This latter point is made eminently clear in a letter from Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, to Maj. Gen. E. B. Gregory, the Quartermaster General, under date of November 20, 1943, in which he writes:

"Within recent weeks it has come to my attention that there is considerable discussion about the genesis of the jeep. I am told that one author is gathering material for a book in which he intends to present the story of the origin of this remarkable vehicle in considerable detail. In so far as the Ordnance Department is concerned, I have a deep conviction on the subject and I am anxious that you should know about it.

"Even without the tremendously widespread public interest that has been shown in the jeep from the very first, it still would be easily one of the outstanding automotive developments of this war. All of us in the Ordnance Department fully realize that this vehicle was developed and put into production by the Quartermaster Corps prior to the time when Motor Transport was transferred to the Ordnance Department on August 1, 1942. None of the credit for this achievement belongs to the Ordnance Department and it would be presumptuous on our part ever to allow a shadow of doubt on this point. Therefore, I am sending this note to assure you that anything that may be said or written on the origin of the jeep is entirely within your province and not mine. It is a very remarkable achievement for which the Quartermaster Corps, and those who worked for or with it, are entitled to credit. We of Ordnance join with all your other friends in giving this credit completely and gladly."

From the original pilot models submitted by Bantam, Ford Motor Company, and Willys-Overland Motors, Inc., which were tested again and again on one of the stiffest courses in the country at the old Holabird Quartermaster Depot in Baltimore, and from the 1,500 vehicles built by each of these manufacturers in 1941, the Willys model was finally chosen by Army engineers as coming the closest to meeting Army requirements. The Willys bid was lower and the Willys motor had greater power. However, the decision to standardize on the Willys model was reached only after grueling operational tests on maneuvers and in Army camps from one end of America to the other.

Two sources were then obtained for manufacture of the standardized vehicle at the instance of the War Department and as a result of a personal request made by General Gregory and two officers of his staff to Edsel Ford of the Ford Motor Company. Having learned that Mr. Ford was in Washington, the officers were on their way to see him when they met the industrialist in a corridor of the Social Security Building. Accompanying General Gregory were Brig. Gen. H. J. Lawes and Col. E. S. Van Deusen. General Gregory, in effect, said: "Mr. Ford, the Army wants to standardize this vehicle. We also want two sources of supply. You and your company can do the United States and our Army an immeasurable service in this war if you will agree to manufacture this vehicle according to the Willys design, with the Willys motor and every single part interchangeable." The idea was revolutionary, but without hesitation Mr. Ford replied: "Gentlemen, the answer is yes."

It was as simple as that—with the long hours of tooling up and the exacting labor coming later. As a result of this agreement, Willys turned over its patents, specifications, and drawings of the ¼-ton, 4x4 truck to Ford, and the armies of the United Nations were supplied with a unique vehicle, the parts of which are interchangeable. Such coöperation on the part of industry is almost unparalleled, and the results in World War II, from the point of battlefield maintenance, are incalculable.

ONCE accepted by the Army and standardized as a military vehicle in 1941, the jeep was put into mass production and was exported almost at once. Russia was one of the first foreign nations to receive jeeps. The Red Army quickly learned the value of these vehicles and found them exceptionally good because of their 4-wheel drive for operation in the mire of Russian roads that were chopped into sloughs of mud by endless military traffic. Soviet representatives lost no time in asking for more. To date, 20,000 jeeps have been sent to Russia under Lend-Lease.

Jeeps have indeed been sent everywhere. From Iceland to the Solomons, and from Burma to Italy, jeeps have sped, bounded, and scurried over the world battle map, doing a million and one odd jobs in this war. The date and place that a jeep first went to war and the battle in which a jeep first served are unknown and can never be proved. This probably was in Burma early in 1942 when Jap forces plunged south and took Rangoon. The piers there, in those unhappy days, were lined with boxed jeeps that had been shipped all the way from Detroit and Toledo for assembly in Burma and for driving over the Burma Road into China.

Men worked frantically under the blazing sun to assemble as many jeeps as precious time permitted, and these were turned over to British troops and to any one else who would

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drive them northward. Others were burned in their packing cases and pushed into the sea. By hundreds they were driven straight into war; they crossed rice paddies where no other trucks could go; they patrolled roads, towed guns, saved civilians. Writing from Mandalay in March 1942, Leland Stowe, famous war correspondent, said: "The American Army's scout car has won its service stripes and will probably be famous all over the world before the war ends." The jeep's heroic value had been dramatically proved—only to be repeated time and time again as the war went on.

Jeeps have been driven by fighting men of all the United Nations and have been assembled by mechanics and native workers in Asia, in Africa, and in the frozen North. These men have cheered as they ripped the weathered sidings and lifted the "knocked-down" components of jeeps from the long rectangular pine boxes that came to them from U. S. Army Ordnance depots in America.

A JEEP HEADS A GERMAN PRISONER COLUMN IN ITALY

In North Africa during the war there was a vehicle assembly line manned by French troops of Les Chantiers de la Jeunesse and directed by American enlisted men under the command of American Ordnance officers. It took fully twenty-five minutes to run the first jeep through the assembly lines and only twenty-one were finished by nightfall the first day. When this line got into its stride, however, one jeep rolled off every 9½ minutes! Four men of a U. S. mobile Ordnance outfit in Libya used their spare time to build jeeps from discarded junk augmented by begged, borrowed, or stolen parts. They called themselves the "Secondhand Jeep Corporation" and actually turned out three jeeps, the first of which was promptly named "Spare Parts" by the unit's lieutenant. All three vehicles were numbered and made a part of the unit's mobile equipment.

ONE of the fastest Ordnance assembly lines overseas was in England. At top speed, the soldiers working there assembled jeeps at the rate of one every three minutes! This magic motor vehicle that the United States had built and sent to help win the war went into service on every type of terrain; it made its own trails in sand and rock, over ice and snow, and in jungles where there were no trails at all. The time even came when military maps of jungle areas had certain trails on them marked "jeep roads."

Many are the tales that have been told about the jeep. The name—a new word in our language now in spite of the Army's original objection to and discouragement of its use—appears in virtually every book written about the war and almost surely in every press dispatch mentioning motor vehicles. Clare Booth Luce, Richard Tregaskis, Ernie Pyle, Robert Sherrod, John Hersey, and many others—all have written about the jeep. Jeeps in World War II early became the symbol, the trade-mark, the *alter ego* of "G. I. Yank." One dark night during the campaigns in Africa a French trooper on sentry duty at a crossroads in Tunisia was approached by several soldiers on foot who answered his challenge by calling out that they were Americans. Without another word the sentry killed them all with his submachine gun and reported what he had done. Examination of the bodies disclosed that the dead soldiers were German infiltration troopers in American uniforms. His commanding officer asked the sentry how he knew they were Germans. "That's easy, sir," the sentry answered, "all Americans come in jeeps!"

In the hot, deep jungles of the Pacific islands, the sight of jeeps became as familiar to woolly-headed natives as the sound of rifle shots. In far countries, hot and cold, Army chaplains have used jeeps' flat hoods to support their altars, Army nurses have washed their faces from "tin hats" on jeep hoods. Jeeps went ashore from landing craft with the initial waves of allied forces that invaded France on June 6, 1944. Almost immediately, the story was told of a British surgeon who used a rubber tube from a jeep to enable a wounded commando to breathe while operating on him. Jeeps have been placed athwart lifeboats and sent ashore with reconnaissance parties onto Pacific islands. Robert Sherrod in his book "Tarawa" wrote: "Now at three minutes past six, the first two American jeeps roll down the pier, towing 37-mm. guns. 'If a sign of certain victory were needed,' I note, 'This is it. The jeeps have arrived.'"

From the jungles of the Southwest Pacific one supply officer reported to the Ordnance Department as follows: "Working parties consisted of seventy-five native carriers, our own troops who were not actively engaged in the combat operations, and our eight very dependable jeeps. Transportation was very limited, but the jeeps traveled from sunup to sundown over very rough terrain and, as a result, took a lot of punishment. The service company constructed a blacked-out repair shop and, as the jeeps came in at night, they would perform all the necessary repairs. At no time during the entire operation was there a jeep out of action. This was a remarkable feat considering the job the jeeps had to do, and it can truthfully be said that this was a huge factor in the success of the operations."

Another Southwest Pacific report spoke of the problems with which the troops were confronted by lack of good roads, and again the jeep is given high praise. This report stated: "Supply and evacuation operations, because of the conditions in the jungles, were characterized by a series of improvisations, adaptations, some unique inventiveness, and a great deal of sweat. In the course of operations, recourse was had to elevated trolleys across ravines and up precipices, native carriers overland, sleds on grassy slopes, and home-made barges, in addition to the more conventional methods. Throughout the action, the jeep saved the situation time

after time and without that grand little vehicle some of the tasks would have been well-nigh impossible."

THE unparalleled success of the jeep lies in the fact that it has been made to do almost everything. From the routine tasks of the soldier, from the endless "movement of personnel, weapons, and supplies"—the original conception of the use to which the vehicle would be put—the jeep proceeded to serve as a prime mover for 37-mm. guns and for the heavier 75-mm. pack howitzers and as a tractor for the Army Air Forces in pulling planes both on ground fields and on aircraft carriers. Mounted with machine guns, jeeps in the hands of fighting Infantry units became active combat vehicles instead of merely transport vehicles. The Navy uses jeeps for shore patrol and other duties in shore establishments. The Armored Force used jeeps from the very beginning, having tested them in the early days, and some of the men in mechanized units still refer to the ¼-tons as "peeps." In addition to the combat arms, another inveterate user of jeeps is the Military Police, principally for patrol duty and for marching enemy prisoners to stockades. Some soldiers who operate jeeps have labeled themselves "jeepkeepers." A staff correspondent for *Yank*, U. S. servicemen's magazine, told the story of an enterprising corporal—a jeepkeeper if ever there was one—who used a jeep as a pinchhitter for a 2½-ton, 6x6 truck and towed a 105-mm. howitzer for ten long miles in the hot sand of a Sicilian beach!

A STRETCHER-EQUIPPED JEEP FOR TRANSPORTING CASUALTIES

In England and Africa jeeps have been used in place of farm tractors for pulling plows for planting. Jeeps have towed plows to dig furrows for desperately needed Signal Corps telephone lines. The uses to which the Signal Corps has put the jeep are many. It has carried both sending and receiving radio equipment and, thus equipped, has moved up to battle lines. Jeeps carry 2-way radios for continuous contact with unit headquarters and sentries on outlying posts and are used for patrol duty all over the world. On the mountainous island of Trinidad, for example, jeep drivers found that they could use their hand microphones while covering even the roughest road. In Australia, jeeps have been fitted with flanged steel wheels and have been used as switch engines to move loaded freight cars on standard railroad tracks. One Ordnance maintenance battalion in Australia added four extra wheels to the jeep, thereby enabling it to go through even deeper bog than before. Equipped with fire-fighting apparatus, jeeps have also been used as miniature fire trucks!

Driven by an officer of the Northwest African Coastal Air Force, an Army Ordnance jeep, loaded until the springs were down on the axles, carried 25,000 rounds of ammunition and explosives over wild mountain roads in Corsica to supply French patriots who had cornered 2,000 Germans in a defile.

Soon after being standardized, in 1942 the jeep acquired an amphibious trailer which will float even when loaded. Both Willys and Bantam build jeep trailers. Many are the types of supplies that have been hauled in them—everything from howitzer and mortar shells to machine-gun and rifle ammunition, motor-shop tools, telephone wire, bombs, clothing and shoes, and virtually everything an Army uses, including ice cream packed in dry ice!

The Medical Department has made excellent use of the jeep, even to converting a jeep and trailer, both clearly marked with large red crosses, into an ambulance capable of carrying three litter patients, two assistants, and a driver. Again and again, jeeps have served as stretcher bearers, sometimes having been equipped in the field with either a wooden or local shop-welded, double-decker stretcher support. One type of improvised litter carrier transports four patients, two on the vehicle's hood, and two behind the driver. The value of the jeep ambulance is still its great maneuverability over all kinds of terrain in combat areas.

The jeep has figured too in the Army's ubiquitous "spare-parts problem," and has figured more favorably than any other vehicle by requiring relatively few spare parts to be kept running. In war, the truck that runs is the truck that wins. Interchangeability of parts between vehicles is a boon to military men in many ways, and it reduces the number of parts that must be manufactured, thereby saving raw materials. It cuts down on the transportation required both by land and sea, it reduces the storage space required in both rear and forward areas, and generally speeds the actual installations of parts. If it were not for interchangeability, the requirement for all types of vehicle spare parts would have reached astronomical proportions early in the war. In the whole motor story, any Army mechanic will tell you that the next best move after building the jeep was standardizing it.

There's no doubt about the jeep's being tough. One Marine-operated jeep spent four battling months on Guadalcanal and ended up with a ruptured radiator. This vehicle, known as "Norma's Naughty Knight," was once caught in a tropic monsoon that carried tons of silt over a Marine bivouac area and left only the Naughty Knight's superstructure visible above a brand new hill of sand. In a steady tropical downpour, muscular Marines dug the Naughty Knight out of its premature grave, got in, found that the jeep coughed apologetically and then lurched away in the dark.

But those who ride in jeeps are not the only ones who value them. Millions on the home front have followed the jeep in press and film, and the organizations that have obtained jeeps through the purchase of war stamps and bonds are numberless. In many cases an individual vehicle has

been identified as to its donor by a plaque on its side. For example, the students of St. Andrew's School, Erie, Pa., learned through a letter received from 1st Lieut. Samuel H. McAloney of the Marines that the particular jeep they had given to Uncle Sam was the first such vehicle to land on Japanese territory when taken ashore with the Marines in the Marshall Islands.

Along with its mighty bulldozers, the Corps of Engineers has found the jeep indispensable in its endless construction projects throughout the world. Today there are roads in jungles, there are airfields and lesser landing strips behind beaches, on mountains and in swamps that, difficult as they were to build, would have been even more difficult without the jeep. Likewise, the Engineers have used jeeps in malaria control, in bringing up supplies for demolition, for bridge construction, and in their countless other tasks.

THESE are some of the hard daily chores the jeep does. But the jeep has its more exalted moments too. In January 1943, President Roosevelt startled American troops in Casablanca by inspecting them from a jeep, as their Commander in Chief, at the time of his historic conference with Britain's Prime Minister Winston Churchill. Later, in December of the same year, the President reviewed other U. S. forces in Iran from a jeep that had been flown from America to the Asiatic kingdom with him when he participated in the even more historic Teheran conferences with Mr. Churchill and Soviet Marshal Josef Stalin. The President has also made public appearances in a jeep in Egypt, in Malta, in Liberia, and in Brazil.

Gen. Dwight D. Eisenhower, Supreme Commander of the Allied Expeditionary Forces in the invasion of Western Europe, has often made inspection trips in jeeps, as also have Gen. Douglas MacArthur and Gen. Joseph Stilwell. Speaking of the jeep, Field Marshal Sir John Dill, representing the British Chiefs of Staff on the Combined Chiefs of Staff, after his first jeep ride while on an inspection trip at Fort Bragg, N. C., with General Marshall, said: "It can do everything but bake a cake."

Other British military leaders who have personally used the jeep in their own operations include Gens. Sir Harold Alexander, Sir Bernard L. Montgomery, Sir Henry Maitland Wilson, and Admiral Lord Louis Mountbatten who took Generalissimo and Mme. Chiang Kai-shek for a jeep ride in India. General Wilson dispatched a jeep by plane as a gift to Marshal Tito of Yugoslavia. King Farouk of Egypt owns a jeep that was a gift to him from the American Army. When the victorious allied forces entered Rome early in June 1944, Lieut. Gen. Mark W. Clark, commander of the famous American Fifth Army, rode in a jeep to Rome's city hall.

The day has already come when jeeps with operational troops are carried in gliders as well as in planes to land behind enemy lines. This fact has an interesting significance to this writer who, in the March-April 1941 issue of *The Quartermaster Review,* wrote about the jeep: "Some people are even dreaming of the possibilities of carrying two or three of them in a transport or bombing plane!"

Jeeps sent overseas under Lend-Lease have had their dashboards labeled in English, Russian, Spanish, and Chinese. The jeep instructional manual that accompanies vehicles has been printed, in addition to the English version, in these languages, as well as in French. Today there are more than 500,000 jeeps in use by the U. S. armed forces alone. Jeeps have, in a very real sense, become a spearhead for allied troops engaged in the liberation of conquered countries. The adaptations and modifications made in the field to these highly adaptable vehicles are a tribute to the American soldier-mechanic's resourcefulness, just as their production in the first place is a tribute to American engineering ingenuity.

In their own way two jeeps have gone to "heaven." In May 1944, "Gramps," the most venerable jeep in existence—the oldest one left of the original sixty-two 2-wheel-steer models built by the Bantam Company in 1940—came to its final and dignified resting place in Washington in the Smithsonian Institution's hallowed hall of fame. Much searching through Ordnance records and files took place before Gramps was finally found, as chipper as ever in spite of a few spare-parts injections, at the Jeffersonville Quartermaster Depot where he was still tearing around as a staff car. So, bearing the registration number USA 2015330, Gramps obeyed the orders of his superiors and was "kicked upstairs" into the white light of posterity's view.

Gramps' rival is "Old Faithful," a Willys-built jeep that served four Marine generals through the Guadalcanal campaign and the Bougainville invasion. What Gramps has in seniority, Old Faithful boasts in service, for Old Faithful was officially awarded the Purple Heart for "wounds"—two shrapnel holes in its windshield received during the Jap battleship shelling of Guadalcanal on October 13, 1942. Old Faithful, the first American vehicle ever to be so decorated, was retired from active service by official Marine Corps order on December 22, 1943. Faithful to the last, this jeep's motor, which has never been overhauled, purrs as smoothly today as it did on the historic day of August 7, 1942, when it first rolled onto Guadalcanal's famous Lunga Beach. During its duty in the Pacific area, Old Faithful served as official car for many distinguished leaders including the late Secretary of the Navy Frank Knox, Adms. Chester Nimitz and William F. Halsey, Vice Adms. A. W. Fitch and J. S. McCain, Marine Corps Commandant Lieut. Gen. Thomas Holcomb, his successor, Lieut. Gen. A. A. Vandegrift, and many others. In 1944, Old Faithful, after a long journey, arrived in "heaven" and now reposes in the Marine Corps Museum at the Marine Corps Air Station, Quantico, Va.

PROBABLY the best known name in the U. S. Army today is "jeep"—the glamour vehicle of World War II—America's ¼-ton, 4x4 truck. Wherever it goes, the jeep writes its own history. It has done everything and has been everywhere—it has even been to sea! In 1942, a new kind of jeep was put into quantity production, a jeep with a sort of boat body or bathtub hull and a propeller that together enable this versatile car to travel on water as well as on land. The amphibious jeep, known colloquially as the "seep" (a contraction of the words "sea jeep") together with its big brother, the 2½-ton, 6x6 amphibian called the "duck," is playing its part in crossing rivers and in landing troops.

In every sense, this battle-scarred veteran—the famous, fabulous jeep—has met all expectations. In producing jeeps by the hundreds of thousands, the Ordnance Department has worked hand in glove with both Willys and Ford and has found both coöperative to the nth degree in assuring the required number where and when they were needed. Any general, any soldier, will tell you that the jeep is one of America's major contributions in World War II. There is no end to the legend of the jeep!

Maintenance Crisis in the Pacific

An Ordnance Battle against the Elements on Espiritu Santo

Dr. John J. O'Connor

IN the critical days before the strategic island of Guadalcanal finally fell to the American forces, the southward march of the Japanese was a threat that the Americans were moving north to meet. If the battle equipment of American task forces was not repaired quickly, the Japs were likely to strike from Guadalcanal and add the New Hebrides to their Solomon Islands conquests. On little-known islands, secret bases sprang into being overnight. Arms and ammunition and fighting men piled up at reënforcement points to back the first waves of U. S. task forces in assaults on Jap-held islands. One of the most strategically important of these secret bases was the once romantic island of Espiritu Santo. On this island, the best weapons of the best fighting army in the world were being silenced one by one, not by the Japanese but by a whole horde of jungle enemies—heat, rust, mold, mildew, fungus, termites, and beetles.

The occupation of Espiritu Santo by the Japs would cut the United Nations' lifeline of supply in the South Pacific and would give the Japs another springboard for the invasion of Australia. If the Japs moved in, the whole American task force would be cut to pieces, and the American drive on the Philippines and Tokyo would be indefinitely postponed. The big question was whether the Japs would arrive at Espiritu Santo before Army Ordnance service troops. A few dozen Ordnance gun doctors and mechanics would make all the difference in the world—would give the Yanks a fighting chance against the prowling Nips.

This was the critical situation that confronted Lieut. Gen. Millard F. Harmon, Commanding General of the United States Army Forces in the South Pacific. Unfortunately, no Army Ordnance troops were immediately available, so General Harmon did the next best thing; he rushed an ingenious Ordnance officer on his staff, Lieut. Col. L. B. Williams, to the beleaguered and stricken island. This never-say-die Texan moved in with both fists. He put the task force in combat condition again in quick time—even though he had to canabalize the crippled warships of our Navy to do it. By an odd turn of fate, a direct Jap hit on an American battlewagon in the tough Coral Sea battles was, in reality, an aid to the Colonel's victory.

On the map, the small island of Espiritu Santo in the New Hebrides is less than half an inch from Guadalcanal. It will go down in American history as the island that flashed the first red light on Japanese dreams of empire. There one lone Army Ordnance officer achieved an unpublicized victory of epic proportions for he restored the combat strength of the great American invasion force that drove the last Japs out of Guadalcanal, chased them back from Port Moresby, routed them on New Georgia, and mauled them badly in the Buna and Sa[illegible] campaigns.

In the desperate summer of 1942, while the Japs were driving through the Netherlands East Indies at a fast clip, a formidable American task force was hastily put ashore on hot, moist Espiritu Santo with orders to hold the strategically important island at all costs. The tiny tropical British-French island was inhabited by only a few frail wide-eyed Polynesians, and, except for a coconut plantation under spasmodic cultivation near the shore, the jungle was a mysterious unbroken wall.

Combat vehicles, guns, ammunition, and general supplies were received, and Army, Navy, Marine, and Air Corps combat units made ready, as best they could, to fight it out with the predatory Japs. A vast amount of defensive work was carried on at a frantic tempo. Air strips were hacked out of the jungle, heavy seacoast guns were emplaced, machine-gun pillboxes were constructed, antiaircraft batteries were posted along the beaches, and antisubmarine patrols were inaugurated. If the Japs had attacked Espiritu Santo during the first few weeks of American occupation, they would undoubtedly have been beaten off with heavy losses. The primary reason was that Ordnance battle equipment was in good condition. In subsequent months, however, the deterioration became noticeable, then alarming, and finally almost catastrophic.

OF course, organization tables called for an adequate number of service troops, particularly Ordnance troops, who are charged with the field maintenance and repair of all guns, combat equipment, bombs, and ammunition. But the Japs were striking hard and often in the black months following Pearl Harbor, and it was imperative for the United Nations to slow down and eventually halt this advance. Thus it happened that only combat troops were rushed to Espiritu Santo, but events proved that front-line fighters without accompanying Ordnance and other Army Service Forces troops were like a lot of telephones without a switchboard.

Colonel Williams was neither an engineer nor a mechanic but a veteran Army trouble shooter who had organized or reorganized Army Ordnance depots from Panama to Alaska. When he arrived on Espiritu Santo, the rainy season was just beginning. He found hundreds of vehicles and weapons in need of repair, ranging all the way from pistols to big field guns, and from jeeps to 4-ton trucks. There were 1,800 Ordnance vehicles in various stages of operating efficiency—and not one Ordnance mechanic. There were no Ordnance truck companies, no depot companies, no ammunition companies, no warehouses, no supply dumps, and no spare parts.

Despite the dismal outlook, Colonel Williams had one invaluable asset. This was an order issued by Adm. William F. Halsey to the effect that he wanted the utmost coöperation between the various branches of the armed services. In order to achieve this, he said, he was prepared to rip off all distinctive Army, Navy, Marine Corps, and Air Force uniforms, put all men in anonymous "fatigues," and stamp the letters "U.S.A." on the seat of every man's pants. In short, the peppery admiral wanted a fighting all-American, all-service team in the South Pacific. He got it. The rule books were quietly dropped in the nearest lagoon.

As a practical demonstration of this fruitful solidarity, Colonel Williams talked the gloomy situation over with Lieut.

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Comdr. Robert Lee of Tennessee, commanding officer of the 36th Seabee Battalion. Following this cracker-barrel conference, Commander Lee agreed to assist Colonel Williams in his maintenance problems.

The Seabees had a small repair shop which was promptly expanded and redesignated as a joint salvage and maintenance shop. This shop was made the central headquarters for all available spare parts and the repair of all vehicles on the island. Colonel Williams then made a hasty canvass and succeeded in obtaining fifteen men from the various services who had had some mechanical experience in civilian life. These men were placed on special duty with the Seabees to assist in the repair of all material brought to the shop. If a weapon or vehicle could be repaired, it ceased to belong to a particular company or regiment but was issued to the unit most in need of it whether Army, Navy, Marine Corps, or Air Force. If the item was beyond repair, it was broken down, and all salvageable parts were catalogued and stored in improvised bins.

AT the beginning of this all-service operation, a great number of weapons and at least forty per cent of all vehicles needed repair. In three months, however, this high average was reduced to twelve per cent. Approximately seventy-five per cent of deadlined items were successfully put back in operating condition with the entirely unorthodox help provided by several battered warships.

Meanwhile, Colonel Williams opened an "employment agency" and twenty Polynesians were hired to construct temporary warehouses and ammunition magazines. Bulldozers cleared the jungle, trees were cut, logs were trimmed and fitted, and the natives erected the framework for small huts. The workers then cut leaves from the coconut palms and wove these in such a way that they could be used to form thatched roofs for these huts. Packing boxes in which supplies reached the island were converted into bins for spare parts. These were installed in the huts and an efficient spare-parts depot was born.

Provision also had to be made for the proper dunnage and storage of 45,000 tons of ammunition, including bombs, fins, fuzes, propelling charges, primers, fixed charges, separate-loading ammunition, and small-arms ammunition. Combat troops volunteered their off-duty hours. This meant that they did eight hours of guard duty and then pitched in on back-breaking construction work for four additional hours.

The unloading of supplies from off-shore freighters was always a nerve-racking experience. There were neither docks nor unloading equipment, yet each cargo had to be unloaded by hand as quickly as possible because of the constant threat of Japanese bombers. However, in the period from December 1942 to July 1943, Espiritu Santo was bombed only ten times and the damage inflicted was negligible. Not one ship was sunk, although as many as twenty-five were at anchor at once.

At first each service took care of its own particular share of each cargo. Under this system, work crews had to be shifted frequently and precious time was lost. Colonel Williams and supply officers of other branches eventually organized a permanent cargo crew for all services. As each freighter arrived, twelve men were assigned to the vessel, ten men stored the cargo on barges, ten men received the shipment on the beach, and eight men stored it. On one occasion, Colonel Williams worked ninety-six hours on a stretch, with only a few naps to keep him going. In addition to current operations, Colonel Williams had to prepare requisitions. Since a thorough search of the island failed to uncover even one typewriter available for his use, he was forced to write in longhand an initial procurement order that totaled 180 pages.

But the general situation gradually improved. At one time, it was almost impossible to find a tire patch, but 8,000 tires eventually were landed on the island. B-17 bombers had to be serviced with 1,700 gallons of gasoline per plane out of 5-gallon cans, but gas-dispensing equipment was ultimately secured from the States.

Service troops were shipped in, and life on the island gradually assumed a more normal pattern. Just before he left Espiritu Santo, Colonel Williams had under his command three distinct Ordnance units. One unit consisted of 2 officers and 80 men; a second unit, an Ordnance motor-maintenance company, numbered 6 officers and 180 men; and a third group, a headquarters detachment, consisted of 3 officers and 6 men. When these service troops arrived, they were immediately put to work building semipermanent shops and warehouses. In a short time, a wooden framework was erected for a shop 50 by 160 feet. Salvaged tentage was used to form a roof over this framework, and cement was mixed by hand for the concrete floor. When completed, it was possible to repair twenty trucks at one time in the shop. The Engineers received a shipment of lumber, and temporary warehouses were constructed.

At the peak of operations, each service "borrowed" liberally from all other services. The Navy borrowed machine-gun oil from Ordnance for its fighter planes because existing stocks of Navy oil froze at 30,000 feet. Ordnance borrowed refrigeration and electric power plants from the Navy. Ordnance and the Navy raided the Quartermaster Corps for mosquito netting. A Marine detachment on its way to the Solomons, commanded by Lieut. Col. James Roosevelt, asked Ordnance for eight automatic rifles—and got them in three minutes. There was no delay and no red tape. All that was required for a "loan" was an officer's signature.

THE most outstanding example of friendly larceny on a grand scale occurred when a badly damaged warship put in to Espiritu Santo on its way back to the United States for extensive repairs. Colonel Williams and Commander Lee put their heads together, with the result that Commander Lee went on board and persuaded the captain to lend him the ship's entire machine-tool equipment, arguing that this equipment could easily be replaced when the warship reached a West Coast drydock but would be otherwise unobtainable on Espiritu Santo for many months. Thus, overnight, Colonel Williams and Commander Lee supplied the small joint service shop with lathes, shapers, millers, bench grinders, drill presses, hand tools of all kinds, and badly needed welding material. In subsequent months, other warships and aircraft carriers were visited with equally gratifying results.

When the United Nations' offensive gathered momentum, combat troops left the island with all their Ordnance equipment in prime battle condition. These husky, well-trained American fighting men first came to grips with the Japs on Guadalcanal and New Guinea and have been keeping them on the run ever since.

In July 1943 Colonel Williams at last fell victim to malaria and was invalided home. His job on Espiritu Santo was done. He had the satisfaction of having accomplished a difficult mission in the face of almost insurmountable odds, and today he is serving as Ordnance supply officer at the great Army Service Forces Depot at Belle Meade, N. J.

Invasion

AMERICA'S mighty task in the invasion of France has been borne equally by her military and naval forces. The Navy moved some of its most powerful ships close under the shores of Normandy and blasted the German coastal batteries and beach defenses despite the threat of mines, shells, and bombs. Naval vessels convoyed the invasion fleet, and made possible the successful invasion of Hitler's "European Fortress." It was the guns, shells, depth charges, and torpedoes that made the ships of the Navy effective fighting units and not merely floating targets. It was the machine guns, cannon, high-explosive and fragmentation bombs, rockets, and incendiaries that made it possible for the Air

Signal Corps

men of the Navy manned the great armada of landing craft.

Our air arm, too, contributed its gallant share. High-altitude bombers pounded targets beyond the range of the naval guns. Dive bombers smashed German armor and troop concentrations. Fighters swept the faltering *Luftwaffe* almost completely from the sky and formed an umbrella over both bombers and ground troops. The Army's Troop Carrier Command towed gliders and flew transport planes filled with paratroopers and air-borne infantry who landed miles back from the coast and held off savage enemy attacks until our sea-borne forces could come ashore in strength and secure the beachhead.

Then came the Ground Forces, wading through the surf, slogging up the beach, burrowing in the sand, taking what shelter they could behind every rock, but always inching forward, even in the face of withering fire, until they had carved a toehold on the coast of France.

However, without modern weapons and explosives, the heroic men of our air, ground, and sea forces would have been unable to convert their fighting will power into fighting firepower. It is ordnance, then, both military and naval, that Forces to destroy the enemy on the earth and in the skies. And it was the superior ordnance of the ground soldier that enabled him to crawl out of the sea and drive the Germans from their prepared positions.

Ordnance, then, is the lifeblood of invasion. With it, our forces could conquer the enemy in his own stronghold; without it, they could never even have reached the shore. The Acme invasion photographs on the following pages bring out this point very clearly: Wherever you see a picture of invasion troops, there also you will see a picture of ordnance. The helmet on the soldier's head, the knife at his belt, the bayonet on his rifle are all designed and procured by the Ordnance Department just as are his carbine, hand grenades, bazooka, and grenade launcher. His submachine gun and machine gun are just as much ordnance as are the 105-mm. and 240-mm. howitzers. The jeeps and trucks that transport him and his equipment are also items of ordnance. So too are the tanks, scout cars, and tank destroyers. In brief, practically all the vehicles and weapons used by the combat troops are ordnance—and they are being supplied by the men and women of American industry in sufficient quantity and on time.

Troops Hit the Beach by Sea and Air—

Carrying M1 semiautomatic rifles and other equipment, troops, above, come ashore from the landing craft in the background, while farther out lies the allied fleet waiting to discharge heavy supplies. The paratroopers, below, armed with rifles, carbines, knives, and the new M3 submachine gun, are shown on their way to France as part of the initial attack.

—and Win a Toehold on the Normandy Coast

In the shelter of a seawall and shattered pillboxes, American soldiers, above, take a few moments' rest before pushing inland. Shown on the beach are the steel "jacks" which the Germans placed in the surf to damage landing craft. Below is a general picture of the beachhead area with men and equipment rolling ashore under cover of a low-altitude balloon.

The Fighting Infantry Moves Up

With the air and sea forces of the allies making the English Channel a "United Nations lake," invading troops quickly cleared the beach area and pushed into Normandy as shown in the photo above taken from an "ambulance jeep" bringing casualties to the rear. Below, infantrymen have contacted the enemy again and are using rifles and a caliber .30 machine gun.

Ordnance Reduces the "Fortress Europa"

Victims of American ordnance, the bodies of the crew members of a German headquarters truck, above, lie scattered in the road with their papers and equipment. A bazooka shell caused the destruction. Below is a concrete and barbed-wire machine-gun emplacement knocked out by Canadian troops in breaching Hitler's highly vulnerable "Atlantic Wall."

Street Fighting in France

The two soldiers shown at the right, above, are taking cover from snipers concealed in the ruined buildings up ahead. Much of the rubble in the street was placed there by the Germans to prevent tanks from using it. Below, American paratroopers advance through a French town with rifles ready for snipers. They are on their way to cut the Cherbourg railway.

The Fruits of Victory

Cornered by American forces in a ruined town, German soldiers, above, come out with their hands up in surrender. Below, an American patrol is shown entering Fort du Roule overlooking the strategic port of Cherbourg on the Normandy peninsula. The Germans damaged the port, but it is being restored and soon will be an important entrance for needed supplies.

Food for Guns and Men

One of the major tasks of Ordnance is keeping the thousands of hungry guns supplied with ammunition. Empty shell cases and shell containers around the 90-mm. antiaircraft gun, above, indicate the proportions of ammunition supply. The Quartermaster Corps has a similar job in feeding the invasion troops. Below, a rolling kitchen is loaded aboard a huge LST.

Perishable Tools

Economies Achieved in Small-Arms Ammunition Production

Maj. F. A. Lutz

IN no other field of armament has the rise in production been as dramatic as in that of small-arms ammunition. An Army supply program calling for billions of rounds of caliber .30, .45, .50, and caliber .30 carbine ammunition has been necessary to meet the needs of the rifles and machine guns of modern mechanized warfare. A flight of 50 bombing planes over Germany or the Coral Sea is capable of firing at a rate of 500,000 cartridges a minute. Planes, tanks, ships, and infantry all require high-quality ammunition in prodigious amounts.

Small-arms military ammunition differs as sharply from the sporting ammunition used for hunting, trapshooting, and marksmanship as a tank differs from a taxi. Only such cartridges as those used by law-enforcement agencies and by big-game hunters have any real similarity. Thus, American industry had no established capacity for mass production adequate to supply the vast needs of war.

Since late 1940, 12 huge Government-owned ammunition plants have been built, and these, together with the existing commercial plants and arsenals, have produced over 31,000,000,000 rounds of ammunition for the armed forces of the United States and its allies.

In establishing these facilities it was necessary to design and engineer the first completely modern small-arms ammunition plants ever built for quantity production, and over 33,000 items of special-purpose productive equipment had to be procured and installed in the shortest possible time.

One of the most difficult problems which faced Ordnance and industry was the procurement of the vast quantities of perishable tools used in the production of cartridges. A round of ammunition consists of four main components: cartridge case, bullet, propellent powder charge, and primer. The dimensions and weights of all components must be held within close tolerances. Dimensional tolerances are frequently as small as 0.0002-inch, and therefore the manufacture of case, bullet, and primer components requires precision tools. Of the precision tools, such items as dies, punches, ejecting stems, cutters, and similar instruments which are worn out in producing ammunition, are called perishable tools because they are "expendable."

Perishable tools are essential parts of the production machines and are required in staggering quantities. Furthermore, tools must be manufactured to very close tolerances in order to perform the precision work demanded by the accurate specifications of the finished ammunition. These tools operate at high speeds and under such heavy loads that within two hours some of them are worn beyond tolerance limits and will no longer produce an accurate product. Consequently, worn tools must be replaced. Often the huge production of ammunition required replacement of tools to an extent of 50,000 a day. Approximately 25,000,000 tools have been used in the manufacture of small-arms ammunition since 1941.

Small-arms military ammunition is a commodity without a market in peacetime. Therefore, there were very few people who were familiar with the manufacturing processes required to produce it and fewer still who knew how to make the millions of tools essential to the manufacture of the billions of rounds needed. Fortunately, the Ordnance Department in peacetime had worked industriously on the technique and equipment which were to form the basis of production. The Army's Frankford Arsenal in Philadelphia had compiled and made available the necessary procedures and blueprints.

The perishable-tool problem had two important phases. At first the need for tools was so urgent and so much greater than the existing supply that the problem was one of getting as many tools from as many sources as possible with the utmost speed. In the latter part of the program, the Army supply schedule was cut back sharply, higher quality tools were manufactured as vendors gained experience, tools lasted longer as machine operators were trained, and technical improvements were made. All of this meant that the flow of tools which had been built up to the maximum extent was now more than adequate. The problem then became one of controlling inventories.

STARTING with the few sources available for the production of tools, the prime contractors, in conjunction with the Ordnance Department, had to develop and train hundreds of new vendors. All available capacity at the plants of the few established vendors was quickly overloaded. It was discovered that many good facilities capable of manufacturing tools had prime contracts directly with the Government for other important phases of the war program, and thus these sources were not available for the manufacture of perishable tools. Therefore, to gain sources, vendors had to be developed largely from the more poorly equipped, inadequately organized, and less-skilled small shops often referred to as "bicycle shops." For example, a New England hat manufacturer was persuaded to employ the facilities of his maintenance department to enter the tool field, and an automobile sales agency transformed its showroom into a machine shop and reached a production of 2,000 high-quality draw dies a week for one contractor alone.

In many cases it was difficult to persuade these shops to enter a field with which they were totally unfamiliar. A case in point is the punch and die used for the blanking and forming of the anvil of the caliber .30 cartridges. The die, which is about the size of a dime, is merely a round disk with one specially shaped hole in the middle. This hole is formed by drilling a few holes, then drawing through these holes, successively, twelve specially constructed and highly accurate broaching tools. The broaching tools are expensive and the process of forming this hole accurately is costly, tedious, and demands great precision. Early in production operations, one prime contractor alone required approximately fifty punches and thirty dies a day in order to maintain production.

At one time in the early stages, eight vendors were shown

Major Lutz is procurement officer with the Small Arms Division, Ordnance Industrial Service, at Frankford Arsenal.

	1-1-42 to 7-1-42	*7-1-42 to 1-1-43*	*1-1-43 to 7-1-43*	*7-1-43 to 10-1-43*	*10-1-43 to 12-1-43*	*Total*
Cost at base*	$16,853,807	$47,441,632	$65,979,627	$40,618,241	$26,368,285	$197,261,592
Actual cost	$14,982,203	$28,830,888	$24,777,432	$12,088,698	$ 6,980,367	$ 87,659,588
Savings	$ 1,871,604	$18,610,744	$41,202,195	$28,529,543	$19,387,918	$109,602,004
Actual cost percentage of base	88.9	60.8	37.6	29.8	26.5	44.44
Savings percentage of base	11.1	39.2	62.4	70.2	73.5	55.56

**Mortalities and prices existing on January 1, 1942.*

SAVINGS EFFECTED IN SMALL ARMS AMMUNITION TOOL COSTS BETWEEN JANUARY 1942 AND DECEMBER 1943

the complicated process of manufacturing these tools. Since the manfacture of these items was more involved than the vendors' customary manufacturing processes, they were generally unwilling to undertake production on the basis of this process. Two of those approached would not undertake the manufacture at all. Six others advised they would manufacture these items by their own methods. A few weeks later, two of the six manufacturers encountered such difficulties that they asked to be relieved of orders. Still later, two more dropped out, and the remaining two advised they had not yet been able to make a satisfactory product. The prime contractor thereupon sent his engineering representatives to the vendors' plants to instruct them in the precise steps required. As a result, the two vendors finally were able to produce satisfactory tools.

CIRCUMSTANCES continued in this fashion for months before satisfactory supplies could be secured from tool manufacturers. Although the item was one of the most critical of hundreds of tool items, it illustrates the complexity of the problem of procuring the large number of tools required to produce the ammunition so urgently needed by the troops.

In order to persuade new vendors to undertake tool manufacture and to aid them in reaching satisfactory production, the prime contractors established a force of technical advisers and expediters who spent their time hurrying from one shop to another, teaching, advising, expediting equipment, modernizing methods, and reducing costs. It was due, in large measure, to the efforts of these advisers that vendors became proficient in manufacturing tools in a minimum of time.

Because of the inexperience of the new vendors they had difficulty with Ordnance drawings which were satisfactory for experienced vendors. Therefore, clarification of drawings was necessary. Concurrently, it became evident that standardization of tools was extremely desirable. Hence, the Ordnance Department immediately assigned to a committee established for the purpose the task of creating and maintaining sets of standard tool drawings and specifications. This committee was known as the tool coördinating committee and was composed of members from each of the small arms-ammunition prime contractors. The Ordnance Department acted as a coördinator.

Another very important problem confronting vendors was that of obtaining a sufficient quantity of satisfactory gages and measuring instruments for testing perishable tools. Often, manufacturers of tools had to make or procure their own gages, and it was a long time before lack of gages, comparators, and micrometers ceased to bottleneck the tool supply. In addition, the scarcity of suitable tool steel threatened to be another bottleneck, particularly in the early stages of the program.

Many difficulties were not initially apparent. Vendors who had seemed to manufacture satisfactory tools found their product did not stand up in use. Prime contractors, being apprehensive of their tool supply, pyramided their orders with several vendors in order that the failure of one or two vendors would not create a shortage. Moreover, it must be remembered that practically all difficulties were intensified by the step-up in the small-arms ammunition program caused by the urgency of military demands. Originally it had been anticipated that the early ammunition plants would have machine shops established in time to manufacture their requirements of perishable tools and to build up an initial stock of tools. When the starting date of ammunition production at the Government-owned plants was advanced months ahead of schedule, it was impossible to speed up sufficiently the delivery of equipment and the training of personnel to operate the machine shops at the ammunition plants as originally planned. Therefore the important production of tools in these toolrooms, although of immense value at a later date, was not available when operations actually began.

During this period, tools frequently had to be rushed by automobile from the shops which produced them to an airplane, flown to the city in which the plant was located, and then sped again by automobile to the plant. Otherwise the operation of the Government plants would have been delayed for days and weeks during our most critical period, and the cost to the Government would have been enormous.

A concurrent problem facing industry was the training of personnel. In the early stages, training schools were operated by the prime contractors at their home offices while the new plants were being constructed. As soon as possible these training schools were supplemented by classes in the Ordnance plants. Many key personnel, including foremen and toolsetters, were sent to Frankford Arsenal in Philadelphia. In order to acquire practical experience in the handling of production equipment and perishable tools, the arsenal assigned these men to periods of work under the guidance of experienced machine operators in the ammunition-production lines.

Throughout the perishable-tool program there was constant close coöperation between the Army and the prime contractors. The Industry-Ordnance team, which generally has proved so successful in filling the vast matériel requirements demanded by a war of wholly unprecedented magnitude, also operated to solve the particular problems of the small-arms ammunition industry, including perishable tools. The various committees created by the Ordnance Department, including the Industry Integration Committee and detailed committees thereof, performed invaluable services. Such services included the standardization of tool drawings,

preliminary calculations of tool requirements, and a large amount of exchange of technical information.

As a result of the efforts described above, the initial problem was met. Progress was necessarily slow, but gradually sufficient vendors were trained, and the flow of tools increased so that the long lists of critical tools in 1941 and 1942 largely disappeared in the first part of 1943. Despite all the difficulties encountered, tools were provided to maintain production schedules at the plants.

So successful was the production of small-arms ammunition in huge quantities that, despite the enormous supplies required, the Army found itself in a position to substantially reduce the production schedules for ammunition by the middle of 1943. The extreme character of these reductions is shown by the fact that the program for 1944 is approximately ten per cent of the capacity contemplated in early 1942 and less than one-third of the ammunition actually produced during 1943. Inevitably, this change profoundly affected the perishable-tool program. Supplies of perishable tools previously needed for existing schedules proved more than adequate under the new program. Furthermore, there had already been a steady and, in many cases, drastic improvement in tool mortalities. (The mortality of an individual tool is defined as the number of times that it must be replaced due to wearing out in the production of ten million components.)

One of the most important of these factors in mortality reduction was engineering improvements. While it was necessary for operating personnel to devote their attention in the early stages to maintaining constant operation of vital ammunition lines, as the tool-procurement situation became less critical the time of these men was made available for the study of technical changes affecting the use of tools. These analyses included studies of the most satisfactory steel for the particular application, improvements in heat-treating, changes in dimensional tolerances, refinements in finishes of wear surfaces, and the multitude of other changes demanded by the program.

In addition to the results of engineering improvement, still other advantages were obtained by better application of tools. Benefits were realized by the Government in the reduction of machine down-time, in the curtailing of scrap loss, and in the shortening of tool setup time.

MANY other factors served to decrease the quantities of tools required. Entire operations were eliminated in certain manufacturing processes, thereby obsoleting certain tools originally used. Better mirrorlike finishes were introduced, lengthening the useful life of tools. These finishes were measured in microinches and were made in four grades, from "machine grind" to "lap finish," depending upon the use.

The result of the above factors was to reverse the original perishable-tool problem. Instead of being faced with the pressing need for more tools, the problem became one of controlling inventories. To meet this problem, Ordnance instituted a program of industry-wide supervision. It was necessary to completely coördinate the thousand different items of perishable tools on an industry basis rather than on a basis of individual plant needs. Procurement policy had to be reversed from one of purchase and production to one of curtailment and cancellation.

A program involving drastic curtailment of purchases and large-scale cancellation of tool orders was inaugurated. The amount of money involved is illustrated by the fact that the actual cost of tools used during 1943 averaged $5,000,000 a month and reached a peak of over $6,000,000 last July, during which period astronomical quantities of ammunition were being produced.

The Small Arms Ammunition Suboffice in Philadelphia, working with the prime contractors, initiated supervision throughout the industry. Monthly reports were inaugurated, listing tools on hand and on order, rates of usage, and tools available beyond current requirements. These are compiled into comparative tabulations which are distributed to the commanding officers and to the operating contractors of all plants.

ON the basis of these reports, extensive cancellation of outstanding orders for tools was effected. Supplementing this action, strict limitations were placed on the number of months' supply of tools which could be purchased by any contractor. In no case could any tool be bought when a usable tool in excess of current requirements existed in the industry.

Weeks of detailed study finally resulted in a specific list of tools which could be converted if the need arose. No tools could be purchased if they were economically convertible from an available item shown on this list.

The industry studies described above on interchange and reworking of tools made possible the mandatory transfer of all usable or reworkable tools among all plants. Naturally, in the early stages, various plants were reticent to accept tools from other contractors, but in spite of the difficulties encountered, the transfer program was persisted in and proved to be a successful part of the over-all program of reducing inventories. An aggregate of over 4,000,000 tools, valued at $16,000,000, were transferred among the various small-arms ammunition plants after January 1943. But for the transfers, these tools would have been purchased at additional expense to the Government.

The integrated exchange of information and the resulting transfer and conversion of tools under cost-plus-fixed-fee contracts produced savings to an extent that would have been difficult to obtain if the same contracts had been on a fixed-price basis. Another important result of interchanging tools has been the utilization of the tools remaining at the seven small-arms ammunition plants whose contracts have been terminated. All the inventories remaining at these plants have been shipped to operating plants and these inventories are being requisitioned to fill the needs of the industry.

The effectiveness of the above controls is evidenced by the fact that, during the past four months, purchases of new tools have averaged less than eight per cent of the tools used. The result has been the reduction of inventories on hand and on order to less than fifty per cent of the quantities in the industry in early 1943. Based on ammunition acceptances from January 1, 1942, to December 1943, improved tool mortalities on caliber .30 and caliber .50 tools have effected savings of $109,000,000 as indicated in the table on page 286.

The results represent a striking example of accomplishment through the coöperation of the Ordnance Department and American industry. Such coöperation throughout the small-arms ammunition program is chiefly responsible for its outstanding success, well described by the Chief of Ordnance, Maj. Gen. L. H. Campbell, Jr., in these words: "There has been no time, nor will there be such a time in this war, when a single American soldier will lack ammunition."

The Mobile 240-mm. Howitzer Travels in Two Sections

The 240-mm. howitzer M1 is shown above loaded on the transport wagon M2, ready for travel. Below, the howitzer carriage M1 is pictured on carriage transport wagon M3 in traveling position. On reaching position, spade pits will be dug by a 20-ton truck crane using a clamshell bucket. This crane also lifts the howitzer from its wagon onto the carriage.

Our 240-mm. Howitzer

Heaviest Mobile Field Weapon of the Army

Lieut. Col. G. M. Yatsevitch

AT the end of World War I, the Ordnance Department sent a board of officers to Europe to make a thorough study of the effectiveness of the various types of artillery employed during that conflict and to determine the types most suitable for adoption by the United States Army as standard equipment. When the "Caliber Board," as it is generally called, returned from Europe in 1919, it recommended the development of a 240-mm. howitzer having a maximum range of 25,000 yards.

In accordance with this recommendation, preliminary design work was undertaken by the Ordnance Department in 1920, and various studies were made during the next four years until, in 1924, the development of heavy mobile artillery was temporarily suspended because of limited funds and the higher priority of certain smaller weapons for the field Army. Active work on this project was not resumed until the end of 1939, when the whole problem was revived. Early in 1940, the Chief of Field Artillery submitted desired military characteristics for the new 240-mm. howitzer as shown in the table on this page; the new characteristics were approved by the Ordnance Technical Committee in short order; and the development project was formally initiated.

Characteristic	*240-mm. howitzer M1*	*Desired military characteristics*	*240-mm. howitzer M1918*
Weight of cannon (lbs.)	25,000	.....	10,790
Weight of carriage (lbs.)	39,600	.....	.....
Weight of cannon & carriage in firing position (lbs.)	64,600	.....	41,296
Length of bore (cals.)	35	.....	19.75
Length of cannon (in.)	331	.....	199.6
Muzzle velocity—max. charge (ft./sec.)	2,300	.....	1,700
Range—max. (yds.)	25,000	25,000	16,400
Weight of projectile (lbs.)	360	345	345
Weight of powder charge—max. (lbs.)	90	.....	36.5
Rate of fire (rounds per min.)	1—1½	.....	½
Max. elevation (deg.)	65	65	60
Min. elevation (deg.)	15	15	—1
Traverse (deg.)	45	45	20
Weight of cannon & transport wagon (lbs.)	47,720	40,000	Broken down into 4 loads carried on 4 wagons weighing approx. 15,000 lbs. each when loaded.
Weight of carriage & transport wagon (lbs.)	51,100	40,000	
Time required for emplacement (hrs.)	1½—4	6 (max.)	4
Max. powder pressure (lbs. per sq. in.)	34,000	.....	33,000

MILITARY CHARACTERISTICS OF THE 240-MM. HOWITZER

The preparation of the designs and drawings and the manufacture of the pilot model, together with the necessary service tests, were completed within a period of approximately two years, and quantity production of the 240-mm. howitzer M1, in its latest form, began in 1942.

The 240-mm. howitzer M1 is a modern, long-range, and relatively high velocity cannon which will fire a 360-pound projectile to a maximum range of 25,000 yards. As the most powerful and heaviest field howitzer used by the U. S. Army it is assigned organizationally to the army artillery, which is kept under the direct control of the army commander for support of the army as a whole, and has for its principal missions distant interdiction and destruction fire and reënforcement of the fire of corps and division artillery. Among the targets for which this howitzer is particularly suitable are permanent fortifications and reënforced-concrete structures of various types.

THE howitzer itself consists of an alloy-steel tube on which is shrunk an alloy-steel breech ring. The smoothly finished cylindrical portion of the tube provides a bearing surface for its support and alignment in the mount. The breech mechanism is of the interrupted-step thread type, supported by the breechblock carrier which swings vertically about the horizontal hinge pin carried in a hinge lug on the bottom rear end of the breech ring. It is manually operated by means of two handles, one located on each side of the breech, and by a lever, and it is counterbalanced by two spring and cylinder type counterbalance assemblies attached to the bottom of the breech ring.

The howitzer is hand-fired by means of a lanyard-operated percussion hammer which strikes the firing pin in the firing-mechanism block, an assembly which is similar to the firing-mechanism blocks used with the 4.5-inch gun and the 155-mm. gun and howitzer.

The recoil mechanism is a hydropneumatic device of the Filloux type, having a constant length of recoil. The recuperator is located above the cannon and the recoil cylinder below, and the entire system remains with the cannon when the carriage is broken up for traveling. The equilibrators consist of two hydropneumatic cylinders, located beneath the false cradle, and a single expansion tank mounted on the front of the top carriage. It functions to neutralize the unbalanced weight of the tipping parts and serves to reduce the manual effort required to elevate and depress the howitzer.

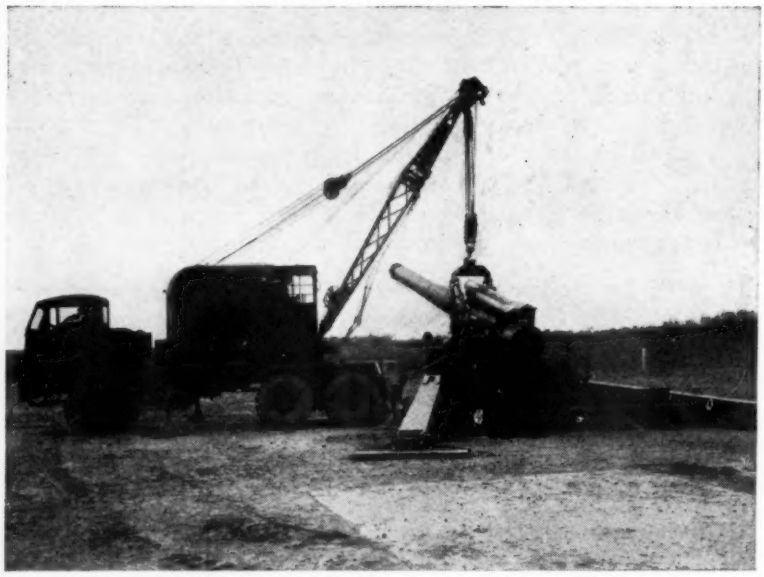
The carriage consists of a false cradle, top carriage, bottom carriage with its trails and floats, and the necessary elevating and traversing mechanism. The major members are built-up welded structures, so designed as to permit high elevation and wide traverse and at the same time break down into readily portable components.

The false cradle is a built-up weldment designed to allow

Colonel Yatsevitch is chief of the cannon and aircraft armament branch, Artillery Division, Ordnance Industrial Service.

the cradle, together with the recoil mechanism and cannon, to be removed from the carriage for transport without disturbing the trunnions, elevating and traversing mechanisms, and equilibrators. When the proper fastenings have been removed, the cradle is free to be lifted out of the false cradle either by using the truck crane provided for that purpose or by means of hand-operated screw jacks.

The top carriage is a built-up welded structure supporting the false cradle at the trunnions and providing a connection for the equilibrators and their reservoir at the front as well as a support for the elevating mechanism on its right and the traversing mechanism on its left. The bottom carriage forms the chassis for the entire carriage and carries the trails which are hinged to it at the rear and are spread for stability when the carriage is in the firing position. This permits the cannon breech to pass in recoil at all angles of elevation and to traverse right and left of the center line of the carriage. A tie member connects the trails and serves the dual purpose of restraining the spread of the trails when in action and forming a support for the loading ramp when the howitzer is being loaded.



TRUCK CRANE PLACING HOWITZER ON ITS CARRIAGE

The elevating mechanism is designed for a minimum elevation of plus fifteen degrees and a maximum of plus sixty-five degrees and has two speeds. It incorporates a gear train consisting of spur gears mounted on antifriction bearings. The traversing mechanism embodies a worm-and-spur gear and is operated through a controlling handwheel conveniently located on the left with respect to the left-side sighting station. A traverse of 22.5 degrees to either side of the center line of the carriage, or a total traverse of 45 degrees, is possible.

THE HOWITZER IN FIRING POSITION, FULL LEFT TRAVERSE

Each weapon is provided with two rubber-tired wagons, one for transporting the cannon and the other the carriage. They are designed for high-speed transport and are capable of being towed at speeds equal to that of the prime mover—a heavy tractor. Both types have three axles and unsprung frames, air brakes on the four rear wheels, and a fifth-wheel type steering arrangement.

THE cannon transport wagon is a rigid welded structure having sills of box section, smooth on top and of proper width to form a rollway for the cradle when the weapon is being set up for firing or being broken down for transport with the aid of a winch. In addition to carrying the cannon, this wagon also carries certain of the accessories. The carriage transport wagon is also a welded structure having sills of box section, smooth on top to provide a surface on which the carriage slides on and off during assembly and disassembly of the weapon by the winch method. The front axle of the carriage wagon is demountable so that the front end of the frame may be lowered to the ground to serve as a ramp on which the carriage may be dragged on and off the wagon.

Two methods have been devised for putting the matériel into firing and traveling positions. The first and preferred method involves the use of a 20-ton truck crane for raising the carriage off its transport wagon and setting it over a prepared position on the ground, after which the cannon, together with its cradle and recoil mechanism, is raised from its wagon by the crane and lowered into position on the carriage. In addition to being used for raising and lowering the carriage and cannon, the truck crane may be employed for digging recoil pits and holes for the spades by means of a clamshell bucket prior to setting up the carriage in the firing position. When this method is used in relatively soft ground, emplacement may be effected in approximately 1½ to 2 hours.

The second method, intended for emplacing the matériel in firing or traveling positions when the truck crane is not available, employs only the prime movers and their winches, together with two hand-operated jacks.

Ordnance Roll of Honor

Ordnancemen have distinguished themselves in the present conflict, as in the past, by their courage, ability, and devotion to duty, often in the face of great difficulties and dangers. ARMY ORDNANCE *salutes the following men and organizations for their gallant achievements as well as the many other Ordnance soldiers whose deeds are an inspiration to their comrades everywhere.*

THESE men have received the Legion of Merit for exceptionally meritorious conduct in the performance of outstanding service as outlined in the following citations:

LIEUT. COL. RICHARD M. HURST, Mexico, Ind.—"From October 7, 1942, to March 4, 1944, he was charged with the task of organizing and operating the general supply section of the Hawaiian Department Ordnance Office, Central Pacific Area. Through his analysis of supply, evaluation of logistic trends, and forecast of future requirements he developed this section into a highly efficient and smoothly operating organization now supplying the demands of the U. S. Army forces in the Central Pacific Area. His energy, initiative, and technical knowledge reflect great credit on the military service and have contributed materially to the success of U. S. forces in the Gilbert and Marshall Islands."

MAJ. SIMON BUDNER, West Otis, Mass.—"For achievement as executive officer of an Ordnance battalion on the Island of Oahu from October 7, 1942, to March 10, 1944. His zeal and devotion to duty, his able planning and attention to detail have contributed materially to the great expansion of automotive-maintenance facilities in the Central Pacific Area. With his resourcefulness, technical knowledge, and experience he greatly assisted in the establishment of the motor-vehicle assembly plant now in successful operation."

Major Budner

MAJ. JOHN P. MERRILL (then Capt.), Los Angeles, Calif.—"Going beyond his assigned duties as munitions officer, he demonstrated outstanding qualities of ingenuity and mechanical ability during May and June 1943. Knowing of an undesirable characteristic of a rifle grenade launcher he, working on his own time, conceived, developed, and perfected a safety feature that will prevent accidents, thereby giving the troops using this weapon greater confidence and increased combat efficiency. His thorough knowledge of ammunition problems and his untiring efforts were of inestimable value in effecting the rapid loading and transportation of ammunition to forward units. During the initial stages of an operation his careful supervision insured a constant and adequate supply of ammunition at the proper places and times."

MAJ. FRED W. WHITLOCK, St. Louis, Mo.—"From November 16, 1942, to March 18, 1943, he was on duty at an Ordnance Proving Center Winter Detachment in Canada and was charged with the installation and operation of the facilities used in the subzero tests of ordnance matériel conducted at that place. These facilities included highly technical instruments and apparatus, and the operation of them presented unending problems to insure that the tests were conducted at proper temperatures and that the valuable instrumental data were properly measured and recorded. By continuous and brilliant application and the devotion of long hours to his duties he solved every problem as it arose and was able to achieve highly successful results under extreme difficulties imposed by climatic conditions."

CAPT. HERMAN P. KAUFMAN (then First Lieut.), Washington, D. C.—"He conceived, designed, and was responsible for the manufacture of an optical boresighting instrument for accuracy shooting, thereby making an outstanding contribution to the field of Ordnance engineering. The use of the boresighting instrument has saved material, time, and man-hours in the acceptance and development of ordnance matériel and has contributed greatly to the technique in jump firing used in gathering data for firing tables."

Captain Kaufman

CAPT. ALBERT P. NICOL, Corvallis, Oreg.—"For services in the Southwest Pacific Area from April 6, 1942, to February 2, 1944. He demonstrated conspicuous ability while serving on various assignments in connection with Ordnance activities. In the early period he was responsible for maintaining a supply of ammunition at Port Moresby vital to air force operations. Later he initiated, planned, and coördinated a complete reporting system for showing weapons in the hands of troops and ensuring proper and complete supply of ammunition under all conditions. His initiative, fidelity, and resourcefulness were a valuable contribution to the success of our operations." (Captain Nicol was reported missing February 2, 1944, in the Southwest Pacific Area.)

M. SGT. ADRIAN B. WICKA, Los Angeles, Calif.—"Services in New Guinea from July 26 to December 31, 1943. He served as assistant in an Ordnance technical unit of the Fifth Air Force, and was responsible for the development of many new items which have been brought into effective tactical use. He carried out experimental tests to obtain technical data required in these developments, many times volunteer-

ing to fly in testing aircraft under hazardous conditions. On several occasions while air-borne, he made changes in bomb fuzing while bomb-bay doors were open in order to eliminate conditions dangerous to airplane and crew. His ingenuity was demonstrated in devising and redesigning clusters of fragmentation bombs, parachute demolition bombs, and in testing deterioration of fuzes. His technical ability and initiative were responsible for the development of ordnance matériel which has been used with telling effect against the enemy."

M. SGT. HUGH E. MARTIN, Leavenworth, Kans.—"As creator and editor of *The Ordnance Sergeant,* published by The Ordnance School in the interest of Ordnance soldiers, he has constantly displayed extraordinary initiative, creative imagination, untiring zeal, and high professional attainment. The publication of *The Ordnance Sergeant* has insured the widest possible distribution of the most recent developments and modifications relative to ordnance matériel to field units both in this country and overseas."

Sergeant Martin

M. SGT. DONALD A. GUGER, Muskegon, Mich.—"While foreman of a maintenance and repair shop from October 5 to October 20, 1943, he constructed a simple and expedient device for straightening and aligning the wheels of ¼-ton, 4x4 vehicles. Unable to obtain the necessary instruments and machinery through regular supply channels, he improvised equipment and used materials at hand to complete this device. This machine has since been adopted as standard equipment for the Ordnance base armament maintenance battalion and for use by other units. With minor adjustments it has been made available for use on various types of wheels. The initiative, ingenuity, and devotion to duty demonstrated by him reflect the highest credit upon himself and the armed forces of the United States."

M. SGT. WILLIAM E. MCINTOSH, Buffalo, N. Y.—"For achievement as chief clerk of the ammunition section of an Ordnance depot from January 3 to 17, 1944. He effectively coördinated the movement of ammunition from the various supply points at the depot required by the sudden demands for immediate shipping schedules for the Kwajalein operation. This task was accomplished with notable dispatch due largely to his exceptional supervising ability, perseverance, and devotion to duty."

SOLDIER'S MEDAL

THE following Ordnancemen have received the Soldier's Medal for heroic action not in actual contact with the enemy:

1ST LIEUT. PETER CECCATO, Burgettstown, Pa.—"Observing a B-24 crash and burn at an allied airfield in Italy on April 6, 1944, he and three other men immediately rushed to the scene of the accident. Heedless of the intense heat from burning fuel, exploding ammunition, and the imminent danger of the explosion of the aircraft, they made their way through the flames, removing the bodies of the living and dead from the burning wreckage. With complete disregard for their personal safety, they pulled aside sections of the wreckage, and succeeded in extricating members who were pinned beneath the debris, carrying them to safety. By their courage and heroism in risking their lives to save the lives of others, these men have upheld the highest traditions of the military service and reflected great credit upon themselves and the Armed Forces of the United States."

The other three men who participated in this rescue and who received similar citations are: 2ND LIEUT. ROBERT R. WEEKS, Ridgeland, Miss.; T/3 THOMAS E. GRIMES, Claysville, Pa.; PFC. ROCCO J. CANTALUPO, Framingham, Mass.

FIFTH ARMY PLAQUE AND CLASP

TEN Ordnance companies of the Fifth Army have received the Fifth Army Plaque and Clasp for demonstrating "outstanding devotion to duty under most difficult conditions" at Anzio, Italy. The shield-shaped decoration bearing the Fifth Army insignia superimposed on the American eagle is awarded troops in rear areas who keep supplies moving swiftly and efficiently to men at the front.

The 112th Ordnance Company received the award for demonstrating invaluable services to the Fifth Army. In the face of many obstacles, the unit maintained a high record of efficiency. In addition to its ordinary tasks, this company displayed marked ability and willingness to engage in all types of ordnance work.

During February, through some of the toughest fighting at the beachhead, the 525th Ordnance Company repaired and maintained armored units. This company did its work so successfully that a high record of efficiency and versatility was upheld.

The 45th Maintenance Company showed devotion to duty in attaining a peak in maintenance in February far above its normal capacity.

In the face of constant enemy bombing and shelling, the 58th Ordnance Ammunition Company received, stored, and issued thousands of tons of ammunition during operations at the beachhead.

Members of the 3407th Maintenance Company were cited for their technical skill in keeping many "ducks," amphibious landing vehicles, in operation during a critical period.

The 262nd Maintenance Company, despite the hazards of battle at Anzio, displayed profound loyalty to duty in accomplishing its mission.

Maintaining a constant flow of ordnance supply for combat and service troops brought the plaque and clasp to the 77th Depot Company. During February, members of the unit worked tirelessly in performing this vital service.

The 14th Maintenance Company worked out a round-the-clock schedule in servicing vehicles during Anzio battles in February. This uninterrupted schedule was maintained only through outstanding devotion to duty in the face of hazardous battle conditions.

In awarding the plaque to the 101st Maintenance Company, Lieut. Gen. Mark W. Clark, Fifth Army commander, said: "The 101st Maintenance Company has displayed superior technical skill in correcting defects in mechanisms which enabled combat units to increase their firepower."

For the way in which they received, stored, and issued many rounds of ammunition, members of the 66th Ammunition Company were among the Ordnance units receiving the Fifth Army honor.

The Alden Prize

An Annual Essay Award for Ordnancemen

THE Army Ordnance Association announces with considerable pride the establishment of a cash prize to be awarded annually in honor of Col. Herbert W. Alden, president of the Detroit Post, Army Ordnance Association, and chief engineer of the Timken-Detroit Axle Company. The award is made possible through the gift of $5,000 by the Timken-Detroit Axle Company to be held in trust, the income from which will provide the prize of $100 a year. By the terms of the gift the contest will be open to enlisted men, noncommissioned officers, and commissioned officers of the rank of captain or below. The subject of the first essay will be "How Ordnance Training Will Help Ordnancemen Face the Postwar World." The rules of the contest are:

1. This award is open to junior officers of the grade of captain and below, and to all enlisted men.

2. Written contributions should be no longer than 500 words and may be written on anything from brown paper to V-mail.

3. The quality of opinions rather than the literary style will guide the judges.

4. The Committee of Award will be composed of three Ordnancemen—two military and one civilian. The decision of this committee of judges will be final.

5. The winning article becomes the property of the Association and will be published. No articles will be returned unless accompanied by a stamped addressed envelope.

6. The contest closes midnight, January 1, 1945, and all entries must be in the mail before that date. Address your contribution to the Contest Editor, FIREPOWER, % Army Ordnance Association, Mills Building, Washington 6, D. C.

The committee to select the winning manuscript will be announced in the next issue of this journal. The essay will be published in ARMY ORDNANCE and in FIREPOWER.

Through this timely means, the work of a great Ordnance engineer will be perpetuated. Colonel Alden symbolizes the patriotic interest of the American engineer who has devoted much of his time and effort to the advancement of our military armament. He served the Ordnance Department of the Army in important assignments during the first World War. Subsequently and throughout all the years of peace he served as a member, and later as chairman, of the Ordnance Automotive Advisory Committee. This group of automotive engineers, under the sponsorship of the Society of Automotive Engineers, coöperated constantly with the Ordnance Department in the development and production of armed vehicles.

As a result of its designs and plans, the American Army had ready pilot models of automotive weapons which in this war have met the acclaim of all American soldiers and their allies and have been characterized as of superior quality even by our enemies.

COL. HERBERT W. ALDEN

COLONEL ALDEN was the recipient of the Frank A. Scott Gold Medal for meritorious Ordnance service, awarded at the Association's twenty-second annual meeting at Detroit, October 9, 1941, with the following citation:

"The Army Ordnance Association acclaims this leader among automotive engineers for his service to the national defense. Of sound judgment, wide experience, and acknowledged engineering skill, Colonel Alden typifies the best traditions of the patriotic citizen in his allegiance to the national defense. His service to industry and the Army ever has been distinguished by the absence of self-interest and the desire to give the best of his talents to the betterment of military equipment for the defense of his fellow citizens.

"The Association honors Colonel Alden with its Gold Medal bearing the name of Col. Frank A. Scott, whose contributions in the field of industrial preparedness for the welfare of his country have brought about conditions under which engineering for national defense at last is given its proper valuation and appreciation."

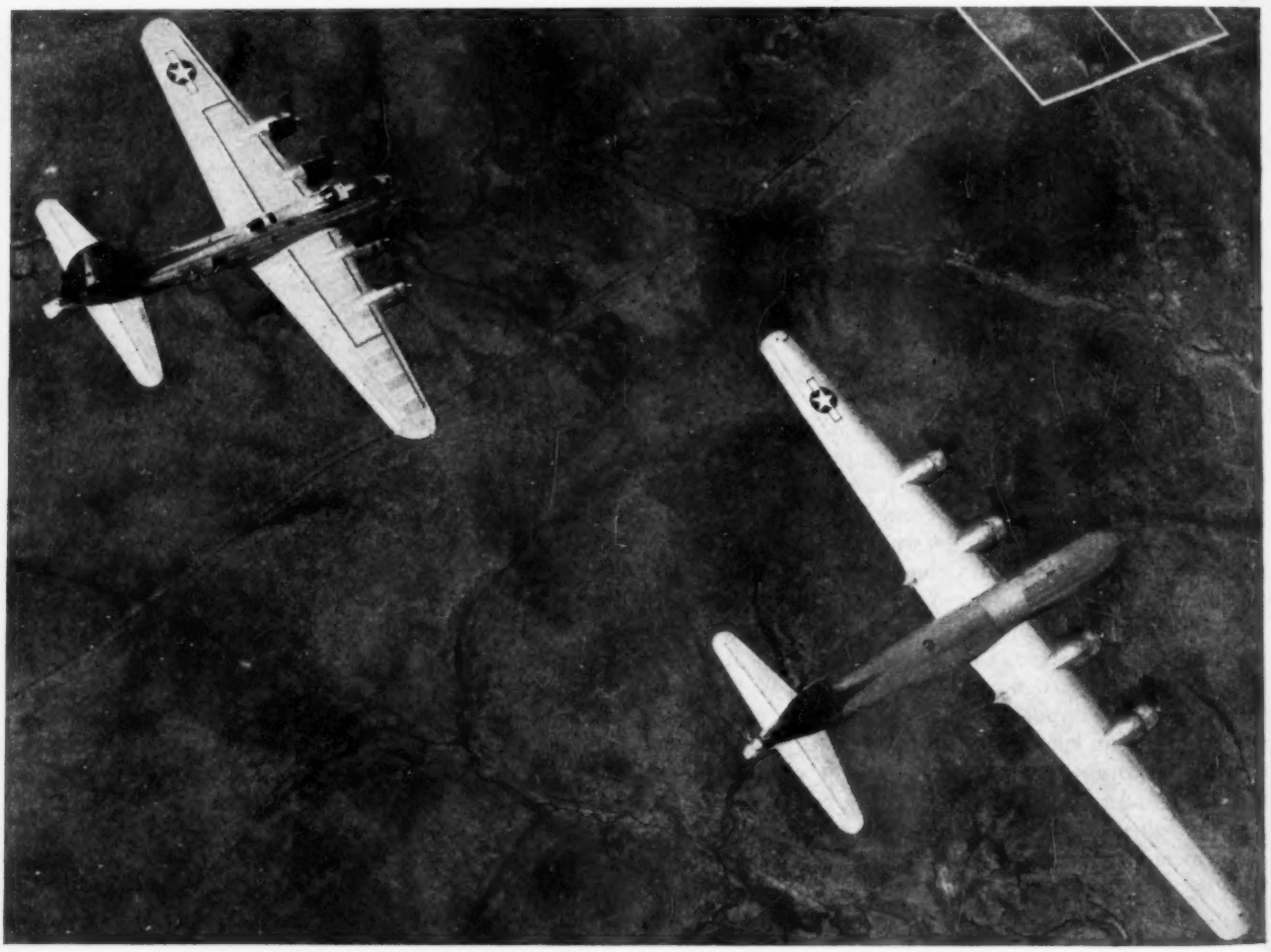
The Association takes this means of thanking publicly the officers and directors of the Timken-Detroit Axle Company for making possible an award which not only honors an outstanding industrial engineer and soldier but which also will keep before the minds of young Ordnancemen the loyalty and devotion to the Ordnance cause with which Colonel Alden's name is synonymous.

Colonel Alden has taken an active part not only in the development of automotive vehicles for peacetime uses but has given unstintingly of his talents in the design and production of military equipment. He was a member of the organizing committee which founded the Army Ordnance Association in 1919.

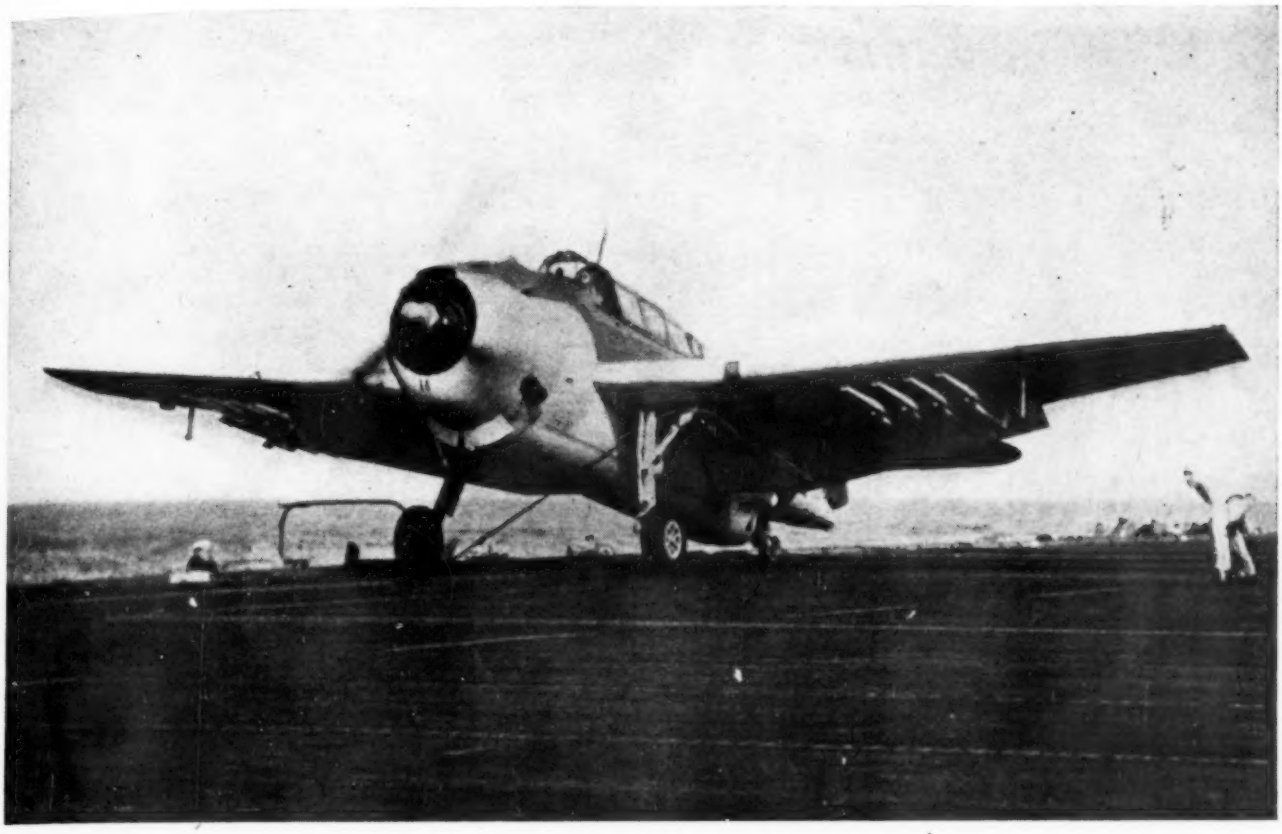
Colonel Alden's service with the Ordnance Department of the Army began in 1917 when, as a major, he was assigned to engineering work on tanks, tractors, and trailers. He was sent to England and France to study tank warfare and to help organize the Anglo-American Tank Commission, on which body he was the American engineering representative. In collaboration with Col. G. A. Green, he designed the renowned Inter-Allied Mark VIII tank. For his patriotic World War service he was awarded the Distinguished Service Medal.

The B-29 Superfortress Heavy Bomber

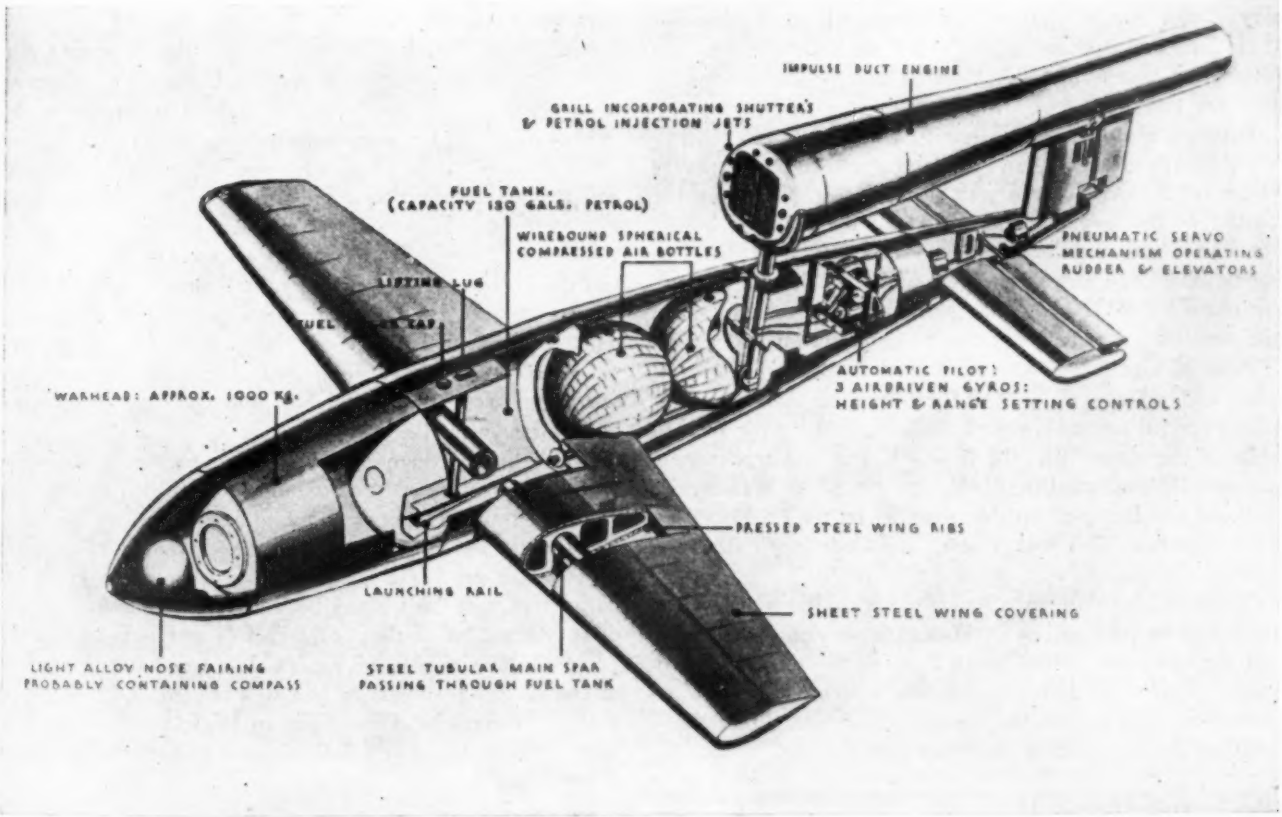
The B-29 Superfortress bomber, America's newest weapon of global air strategy shown in the official Air Forces photos on this page, has a speed of over 300 miles an hour, a ceiling of well over 30,000 feet, and an armament of many cal. .50 and 20-mm. guns. Powered by 2,200-horsepower engines, the B-29 is shown at the right below with a Flying Fortress.



New Weapons for Aërial Warfare



Warfare in the air also has been marked by the addition of rocket launchers under the wings of the Navy's Avenger torpedo bomber as shown in the Navy photo above and by the advent of the German robot bomb illustrated in the drawing below. Called a "rocket bomb" by some, the new weapon is thought to be jet-propelled and guided by a gyro compass.


IMPULSE DUCT ENGINE
GRILL INCORPORATING SHUTTERS & PETROL INJECTION JETS
FUEL TANK. (CAPACITY 130 GALS. PETROL)
WIREBOUND SPHERICAL COMPRESSED AIR BOTTLES
PNEUMATIC SERVO MECHANISM OPERATING RUDDER & ELEVATORS
LIFTING LUG
AUTOMATIC PILOT: 3 AIRDRIVEN GYROS: HEIGHT & RANGE SETTING CONTROLS
WARHEAD: APPROX. 1000 Kg.
PRESSED STEEL WING RIBS
LAUNCHING RAIL
SHEET STEEL WING COVERING
LIGHT ALLOY NOSE FAIRING PROBABLY CONTAINING COMPASS
STEEL TUBULAR MAIN SPAR PASSING THROUGH FUEL TANK

Signal Corps

Ordnance on the Battlefield

Supply and Maintenance in the North African Campaign

Lieut. Col. W. C. Farmer

NEAR Faid Pass in Tunisia, a tank transporter approached a knocked-out tank at a crossroads. The driver turned off the road to circle the damaged vehicle. There was a bright flash accompanied by a loud report and the right front wheel of the transporter flew straight up through the fender. Near Béja another transporter edged slowly past several knocked-out Mark VI tanks. Another explosion, and another wheel sailed through the air. The German *Teller* mines were scoring against our Ordnance recovery units.

Between Sbeitla and Kasserine Pass, an Ordnance heavy wrecker was proceeding swiftly down the road on a recovery mission. Suddenly there was a roar accompanied by the chatter of multiple machine guns and the crash of bullets through metal, wood, and glass. The crew had dived to safety. The lieutenant in charge found a bullet hole through his pistol holster. None of the personnel were casualties, but the wrecker was fiercely ablaze. A Messerschmitt had scored.

Near El Guettar, as a recovery section approached several guns and vehicles which had been knocked out, enemy artillery opened up and dropped shells throughout the area. In spite of the enemy fire, the disabled guns and trucks were successfully evacuated, repaired, and placed back in service without any losses of men or matériel by the Ordnance recovery party. This was a score for Ordnance evacuation against the enemy.

These incidents are but a few of many similar brushes with the enemy encountered by Ordnance recovery parties throughout the campaign. Many times these parties recovered Ordnance equipment and subsequently returned the repaired items to action against the enemy. These results more than justified the few losses of their own matériel.

Colonel Farmer is director of academic training, The Ordnance School, Aberdeen Proving Ground, Md.

Most civilians today are familiar with the word "Ordnance" and, upon hearing it, immediately visualize a mental picture of scientists and engineers bending over blueprints in research laboratories; gigantic arsenals and manufacturing plants spewing forth great quantities of guns, ammunition, tanks, and trucks; and depots with row upon row of spare parts and tools.

Few people know very much about the important rôle played by Ordnance in actual combat. Upon the shoulders of these comparatively few specially trained soldiers rests the responsibility of keeping the infantry, artillery, tank, and other combat troops physically supplied with the weapons and ammunition needed to kill the enemy. Briefly, their mission is to provide mechanical maintenance for guns, tanks, vehicles, and the delicate instruments used to plot and control the firepower of the artillery, both antiaircraft and field; to provide recovery and evacuation to the rear of all ordnance equipment damaged or otherwise needing repair; and to provide the combat troops with the necessary guns, armored vehicles, trucks, and equipment needed to outshoot and outmaneuver the enemy.

It is also an Ordnance function to supply troop mechanics with the necessary spare parts and tools needed to keep the equipment at the front functioning and to furnish ammunition for all guns in the right amount and types as it is needed. In order to provide close support, it is necessary for Ordnance troops to be trained both as technicians and as soldiers. Regardless of the mechanical or technical proficiency of an Ordnance man, he cannot do a good job in support of combat troops unless he is a well-trained and disciplined soldier. Conversely, unless he is an efficient technician, it is impossible for him to render assistance and support to troops at the firing line.

On one occasion, during a threatened tank break-through

by the enemy in Tunisia, a formidable array of self-propelled guns and tanks were manned by Ordnance personnel in a matter of minutes. During the beach landing in Sicily, when a break-through was made by enemy tanks, Ordnance personnel placed in action at close range a couple of 105-mm. howitzers which had just been repaired by an armored maintenance unit.

THE tremendous quantities of Ordnance matériel in our present Army, in comparison with those available in the armies of some of our allies, can well be illustrated by the following incident in Tunisia: A native French trooper was on sentry duty at a crossroads near the front on a dark night. He was approached by several soldiers on foot who answered his challenge by calling that they were Americans. The sentry immediately killed them with his submachine gun. Examination of the bodies disclosed that they were Germans in American uniforms. When asked how he knew they were Germans, the sentry replied: "That's easy—all Americans come in jeeps!"

Probably the most interesting and exciting job of Ordnance is the support of combat units in the battlefield recovery of fighting equipment which has been temporarily knocked out. Time and again in this war Ordnance recovery units have worked their way through mine fields and have been subjected to constant strafing and bombing attacks and artillery fire in order to retrieve and evacuate from the battlefield vitally needed tanks, artillery, and other equipment which had been temporarily put out of action. The quick recovery, evacuation, repair, and return of these items to the hands of the combat troops cannot help but have a very definite affirmative effect on the outcome of a campaign.

It has been said that the prime job of Ordnance in battle is to support the combat troops. Personally, I do not like the word "support." It sounds too much as if you were standing behind somebody holding them up and giving them assistance whenever it is required and has been requested. It is not the job of Ordnance to sit by and honor requests from the combat units for assistance as they come in but to carry Ordnance service forward to the combat troops. We must remember that the prime consideration of any tactical commander is to outmaneuver and outshoot the enemy and not Ordnance recovery, maintenance, and supply. It behooves the Ordnance officer and Ordnance units supporting combat troops to take this load, as nearly as possible, from the shoulders of the tactical commanders in order to leave them free to grapple with and subdue the enemy. This can only be done by pushing Ordnance service forward, personally contacting the supported troops, finding out their requirements, and seeing to it that they are met.

The actual employment of Ordnance troops in combat must take into consideration several factors such as the terrain and disposition of friendly and enemy troops and the type of operation—whether offensive, defensive, or amphibious—in order properly to employ and adequately support the combat troops. In the winter of 1942-1943, troops of the American II Corps were engaged in heavy fighting with the *Panzer* divisions of Rommel's Afrika Korps. The terrain was, for the most part, wide open, and the front was very broad. It necessitated the employment of mobile and, to a large extent, armored combat teams in an effort to block the most likely avenues of approach of Rommel's troops should they attempt to break through to the west as they were driven northward by the British Eighth Army. Some of the battles were of the type that would be a cavalry tactician's dream. Some of them would more nearly approach nightmares than dreams. There was no "front line," and terrain that was traversible by armored and mechanized equipment stretched out on the flanks for a distance of from fifty to one hundred miles.

In order to provide Ordnance support it was necessary to attach Ordnance troops directly to the combat teams and to have them operate in close proximity to these troops which were engaging the enemy. One Ordnance collection point and repair park was in plain view of enemy installations on high ground to the front and was close enough to an enemy airdrome for us to observe our own aircraft making their run as they bombed the enemy airfield. The Germans had air superiority because their airfields were closer to the scene of combat, and therefore it was practically impossible to operate Ordnance recovery or supply on the roads during daylight hours. Both recovery and supply had to be performed at night, and, although it minimized danger of air attack, it increased the threat from enemy patrols and mine fields.

ON February 14, 1943, this particular combat team was very decisively defeated by an overwhelming force of Rommel's *Panzers* and a great concentration of the *Luftwaffe*. The Ordnance detachment had comparatively small casualties, due mainly to their previous training, quickness to obey orders in the heat of battle, and their ability to find their way to the rear over previously reconnoitered routes across country. Many officers and men who were remnants of what had once been the cream of the American Army managed to make their way clear under the cover of darkness in small groups and even individually.

Two nights later the entire force in the area to the rear of the previous battle was ordered to withdraw back through Kasserine Pass and to take up a defensive position on the other side of the mountains. This also necessitated the evacuation of Gafsa in order to keep the garrison at that point from being cut off. This garrison had to be evacuated at night over one narrow road in the rain and during a blackout. The road that night was choked bumper to bumper, from head to tail, with tanks, artillery, infantry, French Legionnaires, camels, goats, sheep, Arab and French families with crying children, jackasses, and horse-drawn carts. Needless to say, it was a mess. The last element in the column was an Ordnance detachment which was sweeping the road. They were pulling everything out of ditches from natives' 2-wheeled, mule-drawn carts to 33-ton tanks. As the other flank withdrew back from Sbeitla, the last people to get out of that town as the Germans entered it from the other side were two Ordnance officers who were attempting to fire our ammunition dump after having poured gasoline on the piles of ammunition.

Our tremendous losses in ordnance matériel in the Faid-Kasserine battle were made up through Ordnance supply channels. Damaged vehicles, guns, and tanks were repaired in wholesale lots by Ordnance mechanics working day and night in order to give the II Corps its full quota of equipment when it attempted to launch the expected counterattack to effect a juncture with the Eighth Army. Ordnance was so successful in meeting this deadline that they were highly commended by the commanders concerned.

I will cite an example of the extreme speed with which some requests for Ordnance service had to be handled. As

the Eighth Army crashed through the Mareth Line and the II Corps was pushing the Germans back, plans were made by the Eighteenth Army Group, under which we were operating, for a series of recognition signals to be used between the advanced armored patrols of the British Eighth Army and the American II Corps. By the time this set of signals reached the commanding officer of our forward patrol the expected juncture with the lead elements from the Eighth Army was less than four hours away.

The system which was to be employed was based on signals used by the British, and we had none of that type of Very pistols or ammunition anywhere in the corps. A hurried call to the nearest base depot at Constantine, some 250 miles to the rear, located the necessary guns and ammunition. They were taken from the depot to the nearest airdrome in a jeep, flown forward to the most advanced fighter field by Spitfire airplane, then transhipped to a Cub airplane and flown forward to the most advanced patrol. This was done in a matter of two or three hours from the time that the patrol commander had radioed that he did not have the necessary equipment with which to exchange recognition signals with the Eighth Army.

MANY people visualize a so-called "front line" as being some sort of line upon which troops are arrayed in battle order facing the enemy. They imagine that it would be impossible to pass beyond it without recognizing it as such. This is generally not true. It is very difficult to realize when you have passed the most forward positions. If you are not careful to inquire about the local tactical situation from the commanders as you proceed forward for Ordnance reconnaissance and liaison, you may find yourself face to face with a German antitank gun or machine-gun nest. Also, the entire over-all tactical picture in a particular sector is liable to change very rapidly and the information which you have received in a rear headquarters and from intelligence maps may be entirely changed by the time you reach the so-called front lines. Time and again Ordnance personnel in this war (including the writer) have been rather abruptly faced with the enemy, much to our surprise and discomfiture, and in some cases disastrously due to the wide-open employment of troops. Too much cannot be said on the subject of Ordnance and other supporting troops' keeping abreast of the local tactical situations.

When a battle is over, the combat troops have some time to rest and rehabilitate themselves. This is not true of Ordnance troops. Recovery, salvage, reclamation, maintenance, and supply must continue in order to get the guns and equipment back into shape for the next battle. Even after the conclusion of a campaign such as in Tunisia or Sicily, the hazards for Ordnance do not stop. The equipment has to be recovered from the battlefields which necessitates entering enemy mine fields and dealing with the ever-present booby traps. In fact, there are going to be Arab farmers in North Africa killed for the next twenty years when they plow up mines, booby traps, and duds which are still buried in that country.

A great part of the war today is of an amphibious nature. Again, Ordnance plays a vital rôle in the preparation for an amphibious assault and in the close follow-up which is necessary to supply ammunition and maintain and supply equipment to the troops who are fighting for their existence on a beachhead. Ordnance has a tremendous job in technically inspecting, repairing, and supplying all ordnance items in preparation for loading them aboard ships and assault landing craft prior to the launching of an invasion. Vast loads of ammunition must be secured from the rear and so placed in the convoys that the troops will be able to have replenishment for their expenditures as quickly as possible, and, based on previous experience, with the types which they will probably need.

Balanced loads of ammunition, spare parts, and replacement items must reach the beach and be available for the troops as quickly as possible. To this end, it is imperative that Ordnance troops land immediately in the wake of the first assault units to provide for the maintenance of the vehicles on the beach and establish beachhead dumps for the resupply of ammunition. Ordnance staff personnel also must be present to coördinate and meet the rest of the ordnance equipment as it comes ashore and conduct it to strategically located sites thus maintaining close support of the combat troops who are pushing inland. Therefore, it is seen that ammunition companies, light- and medium-maintenance companies, and Ordnance staff personnel reach the beach immediately in the wake of the assault waves and attempt to function while still under continuous harassment by enemy artillery, dive bombing, strafing, and enemy counter-attacks. As soon as it is tactically sound to do so, Ordnance must bring in spare guns, howitzers, tanks, tank destroyers, and vehicles to replace those which have been lost in mine fields and knocked out by enemy action during the initial phases of the assault in order to keep the fighting efficiency and strength of the combat units as near the peak as possible at all times.

THE invasion of Sicily was no exception. Ordnance staff officers were attached to infantry combat teams of the assault groups in order to be landed upon the beach as early as possible to keep abreast of the tactical situation, make reconnaissance for Ordnance sites to be used as quickly as Ordnance troops could be brought ashore, establish collection points for knocked-out matériel, both allied and enemy, fulfill ammunition replacements of expenditures, and in general keep abreast of the Ordnance situation and try to establish some orderliness out of the inherent confusion of a beach landing. Probably one of the biggest lessons learned in the Sicilian invasion was that ammunition on the beaches must be handled by trained Ordnance ammunition companies in order to be able to issue the proper types and quantities to the using troops.

In their haste to get away from the assaulting forces, the Italians abandoned complete gun positions without any attempt to sabotage their equipment. I walked into coastal batteries and antiaircraft batteries which were still hooked up with their fire-control systems ready to operate at an instant's notice but which had been abandoned apparently on a dead run at the first indication of our assault. This valuable equipment has to be salvaged immediately by the Ordnance troops. During the confusion of the first few days of an amphibious operation it is more important than ever for Ordnance to get established and to carry Ordnance maintenance and supply forward to the troops, keeping combat troops advised of Ordnance facilities and their location. It is also the task of Ordnance to make available to the troops the right types and quantities of ammunition with which they need to replace their initial expenditures.

Another vital function of Ordnance as we progress forward over a battlefield is to examine all enemy equipment

Signal Corps

AN M7 TANK DESTROYER PASSING THROUGH A LIBERATED TOWN

which has been abandoned in order to ascertain whether any new-type matériel is being employed by the enemy. The information on this equipment must, of course, be immediately transmitted to the proper agencies in the rear, followed by samples as soon as possible. Often only three weeks elapse between that time and uncrating of the matériel at Aberdeen Proving Ground.

Going over a recent battlefield is a rather gruesome business. To see the results of direct hits and the general havoc caused by battle leaves an indelible lifelong impression stamped upon one's mind. It is somewhat of a blow when you suddenly realize that the bodies of your own comrades who have been shot and burned on the battlefield are just as grotesque as those of the enemy and that the stench of your own dead is equally as bad as that of the enemy dead.

THE following is quoted from a report by Maj. Gen. Stafford LeRoy Irwin, a distinguished artillery commander in North Africa, and I believe it very aptly sums up the task of Ordnance in combat as seen through the eyes of a high-ranking troop commander:

"Ordnance fighter-technicians provided a fine example of maintenance morale. Day and night, and under fire, they patched up our guns and tanks and sent them back into combat. They are good scrappers—equally handy with a Garand or a grease gun—plenty of guts and plenty of 'know-how.' Ordnance was always on the job, behind the lines and in the front lines, from Casablanca to Von Arnim's surrender. They kept our tanks and motorized columns rolling over that thousand-mile wilderness of burning rock and sand. They followed us into the hills. They fought beside us at El Guettar. There it was the job of Ordnance to keep howitzers and guns pouring a steady and devastating hail of fire into the Nazi fortifications.

"Whenever a fieldpiece was damaged by enemy ground shells or Stuka dive bombers, Ordnance gun doctors raced up to the front lines to put the howitzer or gun into prime condition. They repaired damaged guns as battlefield surgeons repaired wounded bodies. Ordnance troops fixed our weapons, whenever possible, on the spot while the battle was still raging. They were sniped, machine-gunned, strafed, and bombed. They did emergency repair work in the cold and rain and in complete blackouts. After El Guettar, when our columns surged forward again, Ordnance scrappers kept close to our heels.

"In addition to artillery weapons, Ordnance experts repaired pistols, submachine guns, Garands, armored cars, tank destroyers, tanks, and all kinds of intricate fire-control equipment. They pitched their shops and bivouacs far forward and were cool-headed and resolute under fire. It frequently happened that when the Nazis counterattacked or Messerschmitts began shooting up an American position, battle-trained Ordnance soldiers fought back with the same rifles and machine guns they had just repaired.

"Tank mines were a perpetual source of annoyance. But it was often found that a tank which had been run across a mine field or had been stopped by artillery fire could be put into the fight again quickly by repairs which were relatively simple for our highly trained Ordnance mechanics. Ordnance has every reason to be proud of its battle record in North Africa.

"The combination of intelligent planning, well-defined standing operating procedure, close liaison, coöperation between all elements of combat and Ordnance troops, realization of the importance of the over-all mission of Ordnance service to the successful accomplishment of a campaign—plus well-trained, technically proficient, aggressive Ordnance troops with sufficient equipment—will enable 'Ordnance in Combat' to continue its present hard-earned reputation in assisting the combat troops to wield an ax on the Axis."

ARMY ORDNANCE

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SEPTEMBER-OCTOBER 1944

Month by Month

Robot Bombs.—The Germans appear to be using their new robot "bumble bombs" merely as a means of blind, mechanical destruction with a view to weakening British morale. The fact that they are being used now is regarded as an implicit admission of the weakness of the German *Luftwaffe*.

The robots are described as being the size of a small plane, though different from any existing model. They are driven by rockets or jet propulsion and are said to be launched from ways similar to a section of a roller coaster. At first they were thought to be controlled by radio in accompanying piloted planes, but the fact that they have fallen indiscriminately in various parts of the British countryside leads to the conclusion that they are controlled by some interior mechanism which cannot be set to reach any definite target.

The robots are described by one observer as of the same size and shape as a small fighter plane, with stubby wings. One seen was about forty feet long with a wingspread of twenty-five feet. The fiery exhaust came through a stovepipe arrangement protruding just below a small horizontal stabilizer. The plane's nose was propellerless and blunt. There was no cockpit, hood, or undercarriage.

It is said that two types of the bombs have been used. The first and smaller ones appeared to travel with a speed approximating 200 miles an hour. This was proved by the fact that one was chased and shot down by a Thunderbolt. Later, larger and faster robots made their appearance which passed Spitfires like a shot. Their speed was estimated by Royal Air Force observers as approaching 600 miles an hour.

Just what quantity of the robot bombs the Germans have been able to produce and have in reserve is as yet a matter of conjecture. If they are available in thousands they may have seriously destructive results. It is felt, however, that the bombing of Nazi war production plants during the past few months has probably interfered seriously with German production plans, and that the present attacks may be only another blindly vindictive attempt to do what damage they can in retaliation for the terrific bombings recently given by the allies to Nazi-occupied countries and the German homeland.

Increased Tank Production.—The Army's expanded tank-production program for next year calls for an increase of approximately twelve per cent in output of tanks over the total to be procured during the current calendar year. This will represent an even larger increase from the standpoint of tonnage produced, as the course of the U. S. tank development during the war is bringing about more heavily armed and armored types.

Earlier scheduling called for 1945 production roughly equal to 1944, but prior to the current phase of the fighting on the continent of Europe it was determined that forthcoming operations would call for greater output. The increased deliveries are anticipated from arsenals now making tanks, without the necessity of placing further production in installations now devoted to other matériel.

Economy in War Production.—The combined efforts of the War Department and American businessmen in the field of price and efficiency have resulted in savings to the taxpayer of $12,867,452,000, according to Brig. Gen. Albert J. Browning, director of the Purchases Division, Army Service Forces. This stupendous sum—more than enough to pay the income taxes of every individual in the Nation in the fiscal year 1943—represents money which was appropriated by Congress for the Army but not spent because lower prices were secured.

Acknowledging that such astronomical figures are "meaningless" to most people, General Browning said that the sum saved as a result of price reductions on War Department contracts alone would be enough to build a "task force" consisting of 100 aircraft carriers, 50 heavy cruisers, 4,000 heavy bombers, 50,000 fighter planes, and 6,000 heavy tanks. The amount saved, he continued, equals more than half the total spent on Lend-Lease to date.

Pointing out that the need for increasing production and controlling costs is a common meeting ground for industry and the Army, General Browning said that in addition to desiring to win the war as soon as possible, contractors are becoming "very conscious of the need to enter peacetime operations with a manufacturing organization that is tough and extremely cost-conscious." The far-sighted company, he said, "is more concerned about its postwar position than about war profits."

General Browning announced that as a step in securing the lowest possible prices for war work, the Army has prepared a new contract provision under which the Government assumes the responsibility for those increases in cost over which the contractor has no control.

MEMBERSHIP
in the
ARMY ORDNANCE ASSOCIATION

A MEMBERSHIP SOCIETY OF AMERICAN CITIZENS DEDICATED TO VICTORY THROUGH ARMAMENT RESEARCH, PRODUCTION, AND LOGISTICS

The Association was founded in 1919 to foster an understanding of industry's rôle in our national defense among scientists, engineers, inventors, manufacturers, and other interested Americans, both civilian and military. Its sole purpose is to keep available the highly specialized knowledge necessary for arming the Nation's manhood by stimulating interest in the design, production, and maintenance of our weapons of defense. The Association, a membership organization without subsidy of any kind, is carrying on this patriotic work through its national and local conferences; its bimonthly journal, ARMY ORDNANCE, devoted to armament preparedness; FIREPOWER, also a bimonthly journal for Ordnancemen everywhere; ORDNANCE REPORTS, published from time to time on special ordnance subjects; and its monthly BULLETIN, a Washington newsletter of timely industrial-military information exclusively for members of the Association.

ELIGIBILITY

The following men are eligible for individual membership: 1. All civilian engineers, scientists, manufacturers, and executives of American industry. 2. All members of the military and naval forces of the United States—Regular, Reserve, and National Guard. 3. All others interested in our national defense. American citizenship is a requirement of membership. Dues: Four dollars annually. There is no initiation fee and no other obligation.

APPLICATION FOR MEMBERSHIP

THE ARMY ORDNANCE ASSOCIATION,
MILLS BUILDING, PENNSYLVANIA AVE. AT 17TH ST.,
WASHINGTON 6, D. C.

I hereby apply for individual membership in The Army Ordnance Association and enclose annual dues ($4.00 for one year, $10.00 for three years) which include ARMY ORDNANCE and all other membership privileges for one year from date of admission. The following statements are true to the best of my knowledge and belief:

Name.....
(Print plainly)

Address.....
(Street and Number)

.....
(City and State)

I am a citizen of.....

Race.....

Born at.....Date.....

Educated at.....

Courses.....

Present civil position.....

Previous civil experience.....

.....

Military or naval service (if any).....

.....

If not now in service, was discharge honorable?.....

Present military or naval status.....

.....

References (not necessarily members of the Association).....

.....

.....

Date.....

Signature.....

(Do not write below this line)

Application received.....

Elected to membership.....

Development of New Weapons.—The Ordnance Department now has under development more than 1,000 new weapons and types of battle equipment, according to a report from Maj. Gen. G. M. Barnes, chief of the Ordnance Research and Development Service, which is responsible for the development of new weapons and the improvement of existing ones.

Since Pearl Harbor, over 300 new and improved weapons have been standardized and issued to troops. Current projects range from improvements on rifle bullets up to huge artillery guns; from jeeps to mighty assault tanks and tank destroyers. The effectiveness of Ordnance inventors, under the leadership of General Barnes, is demonstrated by the fact that our Army has been able to meet the enemy on better than equal terms with weapons that are unsurpassed by anything produced by the Axis. General Eisenhower's invasion forces are equipped with new weapons which are the product of painstaking and brilliant research and development by General Barnes's technicians.

In addition to the weapons our Ground Forces use, the Research and Development Service also develops the bombs, guns, and other armament used by our Air Forces. An outstanding example is the 75-mm. cannon used in some of our planes. This cannon is even more powerful than the famed 75's used as field artillery in the last war. Every weapon that our soldiers use is thoroughly tested before it is issued to them. These weapons must work perfectly the first time they are used—there might not be a second time! This careful planning and testing is a deliberate process. In some instances more than a year is needed to develop an item, test it thoroughly, and place it in production.

It is one of the big responsibilities of the Ordnance Research and Development Service to look into the future and determine far in advance the tactical trends and probable requirements of battle so that our troops may be supplied with the proper weapons at the proper time.

Air Power.—Acting Secretary of War Robert P. Patterson and Under Secretary of the Navy for Air Artemus L. Gates appeared before a subcommittee of the Senate Committee on Military Affairs recently and strongly urged that the Nation act now to maintain its air superiority in the postwar world. They asked Congress to: Insure sufficient funds for continuous development of aircraft types; see that the country has a strong aircraft industry; provide for the training of superior airmen; develop commercial aviation; and, above all, make it certain that the Nation quickly, if necessary, can return to war status. Mr. Patterson warned that the postwar military establishment must be maintained on the assumption the United States will not again be given such a period of grace between the start of war and the necessity for full-scale military effort as was provided by France, England, and Russia in the present war.

Indicative of the growth and increased striking force of America's air power is the development of the B-29 Superfortress bomber which already has made more than one attack upon the Japanese homeland. Employed as an arm of global air strategy, the B-29 is a symbol of the union of American imagination, courage, and ingenuity in the defense of freedom.

Gen. George C. Marshall, Chief of Staff, spoke of the new bomber as follows:

"The attack on Japan by the Superfortress B-29 from distant bases introduces a new type of offensive against our enemy. It also creates a new problem in the application of military force. Because of the enormous range and heavy bomb load of these Superfortresses, far exceeding that of previous strategic bombers, they can strike from many and remote bases at a single objective. The power of these new bombers is so great that the Joint Chiefs of Staff felt that it would be uneconomical to confine the Superfortress organization to a single theater. These bombers therefore will remain under the centralized control of the Joint Chiefs of Staff with a single commander, General Arnold, acting as their agent in directing their bombing operations throughout the world. The planes will be treated as major task forces in the same manner as naval task forces are directed against specific objectives.

"This type of flexible, centralized control recognizes that very long range bombardment is not a weapon for the Air Forces alone. Under the Joint Chiefs of Staff, theater commanders will have a voice in its employment, ensuring that maximum effectiveness will be obtained through missions which will contribute directly to the over-all strategy for the defeat of the enemies."

Gen. Henry H. Arnold, Commanding General of the Army Air Forces, also made the following remarks about the B-29:

"The use of the B-29 Superfortress in combat brings actuality to an Air Forces' plan made years in advance for truly global aërial warfare. It proves that our planners and engineers, coupled with the capacity of American industry, are an unbeatable combination. The result is here, a highly complicated and most deadly airplane, capable of delivering the heaviest blows yet known through air power. I assume the heavy responsibility for its employment under the Joint Chiefs of Staff with full confidence in its potential use. This employment of the B-29 makes possible the softening-up attack on Japan very much earlier than would be possible with aircraft hitherto known to combat. This mighty weapon advances the bomber line a long way."

Strength of the Army.—The U. S. Army today has 3,657,000 soldiers deployed outside the continental U. S. in theaters of operation throughout the world, striking and preparing to strike victory-winning blows by land, from the sea, and in the air against Germany and Japan.

This force, at the end of protected supply lines stretching more than 56,000 miles and reaching into every continent, represents approximately 47 per cent of the total strength of the Army. By the end of 1944, the number of troops overseas will be increased to more than 5,000,000 men, approximately two-thirds of total strength.

Already, the U. S. Army overseas exceeds by 1,571,000 men the peak overseas strength of the Army in World War I and is only 400,000 men short of equaling the entire strength of the Army at the close of that conflict.

Today, the U. S. Army Air Forces, with slightly less than one-half of its total personnel of approximately 2,357,000 already overseas, has a total of more than 75,000 airplanes of all types, of which approximately 34,000 are combat aircraft. More than one-half of the AAF's combat plane strength is overseas, making the AAF the world's most formidable aërial striking force in point of size and firepower.

Association Affairs

NEBRASKA POST

THE engineering and production achievements of the Ordnance Department of the Army, coöperating with American industry in the field of heavy artillery, was the theme of an address by Brig. Gen. N. R. Ramsey, commanding general, Rock Island Arsenal, on June 22nd at Omaha, Nebr. The occasion was the inaugural meeting of the Nebraska Post, Army Ordnance Association. More than 300 members and guests were assembled for the ceremony under the chairmanship of C. T. Spier. Maj. Gen. C. H. Danielson, commanding general of the Seventh Service Command, was the principal guest of honor.

Brief addresses were made by General Danielson; Brig. Gen. R. C. Crawford, Corps of Engineers, in charge of the Missouri River Division; Brig. Gen. Paul X. English, chief of staff, Seventh Service Command; Brig. Gen. Guy N. Henninger, head of Selective Service, Lincoln, Nebr.; Col. A. W. Ford, Ordnance Officer, Seventh Service Command; Col. L. A. Codd, executive assistant to the Chief of Ordnance; and Lieut. Col. R. W. Coward, executive officer of the St. Louis Ordnance District.

Karl E. Vogel, president of the Post and general manager of Omaha Steel Works, accepted the charter on behalf of the new organization and pledged the coöperation of the engineers and industry of Nebraska for the progress of American ordnance.

KARL E. VOGEL
President, Nebraska Post

General Ramsey paid high praise to Nebraska's industrial contribution toward winning the war. Industries which heretofore had not participated in any major way for industrial-mobilization planning are now among the leaders in producing the sinews of war. Omaha Steel Works is an excellent example of Industry-Ordnance coöperation, for this plant was among the first to receive an educational order in 1939 and has been engaged continuously since that time in the production of shells for the heavy-artillery program.

General Ramsey also described the principal pieces of large-caliber artillery which have been developed since the beginning of the present emergency. He referred in particular to the 200-mm. (8-inch) gun and carriage and also to the 240-mm. howitzer. The Ordnance Department, traditionally an advocate of heavy guns, has urged for many years the necessity of having ample designs and supplies of siege artillery and the highest quality ammunition. Trends of the present war wherein heavy artillery is a necessary complement to the air arm and to the infantry prove the wisdom of this Ordnance doctrine preached by Chiefs of Ordnance for the past half century and more.

In addition to the guests already named, others at the speakers' table included: Dana C. Bradford, general manager, Bradford-Kennedy Company; Ben Hughes, general manager, Hughes Brothers; B. N. Kilbourn, Dempster Mill Manufacturing Company; John L. McCague, president, Jubilee Manufacturing Company; W. L. Cooper, secretary-treasurer, Cushman Motor Works; Clarence Kirkland, general manager, Omaha Industries, Inc.; Capt. R. D. Campbell, officer in charge of the Dallas Regional Office; and Capt. James Colasanti, secretary-treasurer of the Rocky Mountain Post.

General arrangements for the meeting were under the direction of Capt. F. G. Arkoosh, officer in charge of the Omaha Regional Office of the St. Louis Ordnance District. Captain Arkoosh was ably assisted by Lieut. Arthur April.

The newly elected officers of the post are: Mr. Vogel, president; Charles D. Ammon, vice-president; Captain Arkoosh, secretary-treasurer. The board of directors includes: H. L. Dempster, and Messrs. Bradford, Hughes, Kirkland, McCague, and Spier.

Mr. Vogel is a graduate of the University of Michigan in civil engineering, 1905. He was born in Chelsea, Mich., and has one son in the military service, John P. Vogel, a corporal in the Ordnance Department now in cadre service at Aberdeen Proving Ground, and a son-in-law, Peter Burt, serving overseas with the U. S. Corps of Engineers.

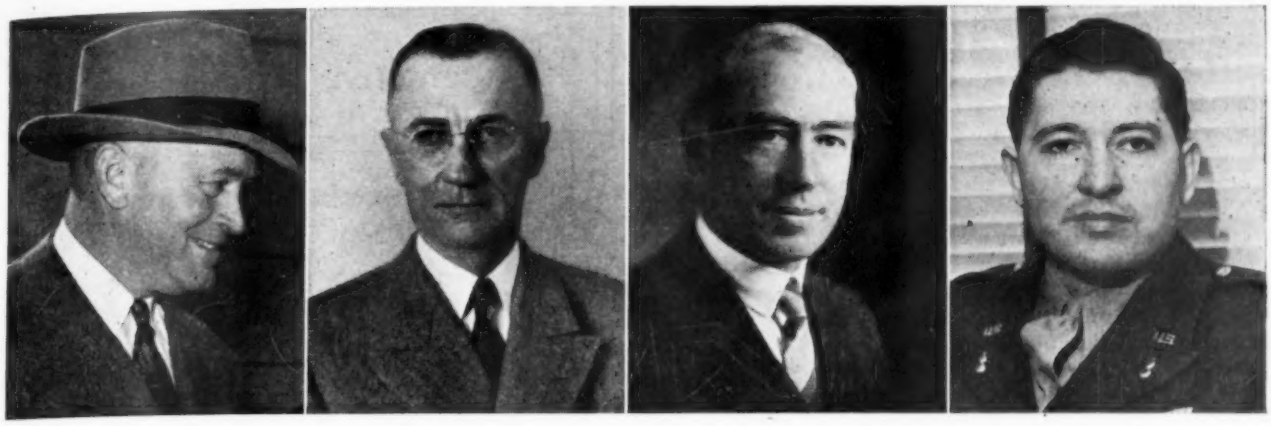
Long-experienced in the steel industry, Mr. Vogel has served with the American Bridge Company at Ambridge, Detroit, and Toledo, and with the Canadian Bridge Company at Walkerville, Canada. In January 1911, he became the first employee and plant superintendent of Omaha Steel Works. He served successively as assistant general manager, general manager and vice-president. His was the task of laving out the plant, building the structures, installing equipment, and training the first crew. The company has enjoyed steady growth and progress under his continuous supervision for the past thirty-two years.

His experience and that of his company in the production of ordnance for the winning of this war is of outstanding merit. Omaha Steel Works was one of the first companies to receive an Ordnance educational order in 1939. It was for the production of 155-mm. shell. Scarcely had the educational order gotten under way when emergency manufacture was required, and the company began full production of this important type of ammunition which to this day it has continued without interruption. The present need for heavy artillery shell would have been far greater had it not been for the interest of Mr. Vogel, the educational order to the Omaha Steel Works, and the splendid management and performance of all personnel at the plant in this most important operation.

A leader in civic and industrial affairs of his city and state, Mr. Vogel is a member of the St. Louis Ordnance District Advisory Board and of the local War Labor Board panel. The Army Ordnance Association welcomes him as an official of its newest Post and congratulates him and all his coworkers on a truly remarkable record for victory in this war.

ORDNANCE LECTURES

THE Washington Post inaugurated a series of Ordnance lectures last February which proved to be one of the most valued activities in which the Post has engaged in many years. With the coöperation of Col. W. R. Slaughter, commandant of the Ordnance School, Aberdeen Proving Ground, and the faculty



Chas. E. Moore *R. C. Force* *Charles Kendrick* *Capt. Ivor deKirby*

NEW OFFICIALS OF THE SAN FRANCISCO POST

Mr. Moore is president and general manager, Joshua Hendy Iron Works; a partner of Moore Machinery Company; president and treasurer, Chas. E. Moore Company. *Mr. Force* is chairman, board of directors, Federal Reserve Bank, 12th District. *Mr. Kendrick* is president of Schlage Lock Company and the Lactol Corporation; vice-president of S. O. S. Corporation and the Cleaner Products Corporation. *Captain deKirby* is public relations and historical officer of the San Francisco Ordnance District. The election of these officers was announced in the last issue.

and staff of that institution, a series of four monthly lectures was presented in the Departmental Auditorium, Washington, D. C. The average attendance at these affairs was 700 persons, indicating the general interest and popular following which the lectures developed.

The program for each lecture followed the same general pattern. Colonel Slaughter presided as chairman; a lecture of approximately forty minutes was presented by one of the officers from the Ordnance School, an expert in the subject assigned, and the talk was copiously illustrated by slides and motion pictures. Following each lecture a panel discussion was presented at which officers from the Ordnance School answered questions from the floor.

It is hoped that similar lectures will be arranged by other local Posts and that this type of Post activity will be widely utilized for the information of members and their guests.

The first lecture, held February 23, 1944, was given by Capt. J. W. Simpson, chief, Small Arms Section, and was entitled "Small Arms Weapons." Members of the panel of experts who participated in the discussion from the floor following the lecture were: Maj. M. R. Vick and Lieuts. L. A. Kollander, M. L. Winch, H. F. Breezley, and T. D. Smith.

The second lecture, held March 29, 1944, was given by Maj. W. C. Farmer, director, Academic Training, and was entitled "Ordnance in Combat." Members of the panel of experts who participated in the discussion from the floor were: Maj. W. F. Register, Jr., Major Vick, Capt. E. F. Boesch, Lieut. W. K. Lewis, Jr., and Lieut. W. G. Meade.

The third lecture, held April 26, 1944, was given by Maj. R. L. Johnson, director, Technical Department, and was entitled "Antiaircraft Artillery and Fire Control." Members of the panel of experts were: Maj. L. E. Clark, Jr., and Lieuts. S. W. Melidosian, E. A. Bugbee, S. R. Gates, and D. E. Kientz.

The fourth lecture, held May 31, 1944, was given by Capt. Halsted James, Jr., senior instructor, Artillery Section, and was entitled "Field Artillery." Members of the panel of experts were: Major Johnson, Major Vick, Capt. H. A. Saroff, Lieut. R. R. Ruland, and Lieut. W. H. Pople.

In addition to the above personnel, the following are also entitled to special mention for their help in making the lecture course the success it proved to be: Capt. Frank D. Dolan, Capt. E. A. Stanush, Lieut. Seth Dennis, Lieut. Leonard Kurtz, Lieut. John B. Payne, T/Sgt. Sigmund Morgenstein, T/4 Robert Bollin, T/4 James Cooke, T/4 Tony Cooper, T/4 Arthur J. Davis, T/4 Harry Kasvin, T/4 Dudley M. Gifford, T/4 Otto Hess, T/4 Martin Lobdell, T/5 W. T. Baxter, T/5 Herbert McClure, Pfc. Ray Ballinger, Pfc. Harold Hackady, Pfc. Norman Ravtiz.

PITTSBURGH POST

LIEUT. COL. THOMAS H. EDDY, formerly secretary-treasurer of the Pittsburgh Post, has relinquished the duties of the secretarial office which have been taken over by Maj. W. S. Rial, Jr., 1202 Chamber of Commerce Building, Pittsburgh, Pa. Colonel Eddy continues as treasurer of the Post.

NECROLOGY

COL. HERBERT O'LEARY, a charter member of the Army Ordnance Association and renowned small-arms expert, died at Walter Reed Hospital, Washington, D. C., July 3, 1944. In his passing, the Ordnance Department has lost another of that valiant band of Ordnance officers and technicians whose influence in the development and production of superior small-arms weapons had untold effect for victory by our armed forces in this war. During the past quarter century, Colonel O'Leary had much to do with the engineering development of American small arms and small-arms ammunition, a place which he shared with such names as Thompson, Wright, and Wilhelm, and all of these, Ordnance officers now deceased, have left an indelible imprint on American arms progress.

A resident of Washington for many years, Colonel O'Leary had served in the Office of the Chief of Ordnance as chief of the Small Arms Division. His last assignment was Ordnance Officer of the Second Service Command with station at Governors Island, N. Y.

Born in Wisconsin on December 22, 1885, Colonel O'Leary graduated from the United States Military Academy at West Point in 1910 and from the Ordnance School of Technology in 1917. After a tour of duty with the Coast Artillery Corps, he was detailed to the Ordnance Department during the last World War, serving at Ordnance headquarters in Washington and in France.

He became chief of the Small Arms Division of the Ordnance Department in 1919, and much of the early experimental and development work in automatic and semiautomatic small-arms weapons was conducted under his direction. He was one of the pioneers in the original development of the machine gun, and the caliber .50 machine gun was initiated in 1921 and developed under his supervision. The forerunner of the present M1

(Garand) rifle also was first developed under Colonel O'Leary's supervision. He served as Ordnance representative on a number of boards and at Fort Benning, Ga., during the testing and further development of these weapons. He also was in charge of small-arms development at Springfield Armory, Mass., 1928-1929, when the Garand rifle was finally developed and made ready for its service tests prior to adoption.

In paying tribute to Colonel O'Leary, Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, said: "Colonel O'Leary dedicated his life to the development and improvement of superior small-arms weapons. His work contributed greatly to the excellence of the American soldier's weapons in this war. The Ordnance Department mourns the loss of one of its foremost small-arms experts."

Lieut. Col. John S. Swauger, chief of the Industrial Division, Pittsburgh Ordnance District, died May 25, 1944, at Deshon General Hospital, Butler, Pa. He was one of the best known and the most influential Ordnance Reserve officers and contributed outstanding service to the work of the Ordnance Department in this war. His contribution was especially noteworthy during the early days of the emergency. Few officers of the Department have rendered services of a more signal character.

He entered the Ordnance Reserve Corps as a first lieutenant in 1929. Throughout the prewar years, he took an important part in all activities of the Pittsburgh Post of the Association. From January 1, 1940, to the day of his death, the vast industrial operations of the Pittsburgh Ordnance District claimed his undivided time and energy and ultimately were responsible for his untimely demise. Born July 9, 1894, at West Newton, Pa., he began his industrial career as a tool and pattern maker and mechanical draftsman for the United States Radiator Corporation. In 1916 he entered the employ of Westinghouse Electric & Manufacturing Company as toolmaker, and progressed through various assignments as tool designer, machine designer, demonstrator, general inspector, and, finally, when he was given leave to enter the armed forces, he was a divisional staff adviser at Westinghouse Micarta Works.

Skilled as a public speaker, he presented many Army-Navy "E" Awards throughout the Pittsburgh area in connection with his duties as executive officer of the Pittsburgh District. His lifetime work ably prepared him to be of great assistance in all phases of the Ordnance industrial effort, and his unfailing zeal and loyalty contributed largely to the success of the district.

Harold Davis Fairweather, vice-president of Colt's Patent Fire Arms Manufacturing Company, died on May 13th after a long illness.

Mr. Fairweather had risen in the company from errand boy in 1902 to vice-president and director, resigning the latter office but a few days before he died at his home in West Hartford, Conn. His long and faithful service to Colt's included such responsible posts as assistant treasurer, treasurer, and executive vice-president. His loss to the company and to the war production effort of the Nation will be mourned by all his many friends and associates.

Notice also has been received of the deaths of the following members of the Association: Harry A. Christensen, Muskegon Heights, Mich.; Harold K. Ferguson, New York, N. Y.; Robert E. Fosdick, Dayton, Ohio; Robert G. Gracey, Muncie, Ind.; Clarence J. Huff, Cincinnati, Ohio; Charles D. King, Raleigh, N. C.; A. C. Lusher, Waterbury, Conn.; C. O. Miniger, Toledo, Ohio; A. Philippi, Jr., Troy, Ohio; John J. Ridgway, Philadelphia, Pa.; L. M. Rossi, New York, N. Y.; F. B. Whitlock, Muskegon, Mich.; George J. Zeller, Arvada, Colo. To their relatives and friends, Army Ordnance, on behalf of the Association membership, extends condolences.

Automotive Maintenance

Winterization Kits for Army Vehicles

Col. W. S. Conrow

What the common cold is to men, the uncommon cold is to motor vehicles—that paralyzing cold of steady, below-zero temperatures that so often have to be coped with in this global war. Just how much time can be lost when vehicles are left to the mercies of the weather overnight is well illustrated in the incident of the two vehicle companies operating in a cold-weather area during the early days of the war.

At the end of one particular day, one unit commander issued orders for each driver to drain the oil and coolant from his vehicle and to remove the battery. These items were then stored in a heated building overnight since a temperature drop had been predicted. The commander of the other unit merely had the coolant in his vehicles checked to see that it contained sufficient antifreeze for the expected temperature drop. The next morning, within a comparatively short time the first unit was operating full force, the heated oil, coolant, and warm batteries having enabled the drivers to start their vehicles immediately. The second unit had only about three vehicles in operation by early afternoon!

Naturally, the process used by the first unit, though very commendable in this instance, is not a particularly efficient method, inasmuch as it takes considerable time and effort. That is why the Army has developed an imposing array of winterization equipment to help fight the uncommon cold. So, if you're on your toes, you can make things a lot easier for yourself just by filling out a few requisitions. The winterization equipment that is now available will help get your vehicles going on the coldest mornings and keep them from struggling through the winter. It may be so cold you have to light your cigarette with a blowtorch because a match flame freezes. You may be numb as a mummy yourself, but your truck has a foot warmer, your tank has snowshoes, and your tractor wears a poncho for a nightgown!

For general purposes, this winterization equipment is grouped into two general classes. Class A items are termed "improvements to the basic vehicle which will be made on all applicable vehicles for future production." That means your vehicles may have them already, but if they don't they can still be installed. For example, the brackets needed to install windshield and door porthole covers must be attached to the vehicle as permanent installations, and therefore are called Class A items. The covers themselves, however, are Class B items, or "items which may be quickly and easily installed and which are necessary for vehicles that are expected to operate in subzero temperatures."

What you will actually order is one of the winterization kits, interim kits, or auxiliary cold-starting aid kits, depending on what vehicles you have. The interim or "quickie" kit is simplest of all. It's the granddaddy of the other winterization kits, as it has been in general use for a considerable length of time, whereas the winterization kit is a much more recent development. The "quickie" kit contains an under-chassis heater and a shroud, and all you have to do when you requisition one is to state the kind of vehicle it is to be used with. In general, these kits are used for vehicles for which no other winterization equipment is provided.

The auxiliary cold-starting aid kits, or "slave" kits, are more elaborate than the "quickies," but they are not so complete as the winterization kits. "Slave" kits contain heaters, auxiliary batteries, and other electrical equipment which is used as an aid

Colonel Conrow is director of the Maintenance Division, Army Service Forces, Washington, D. C.

to starting in cold weather. Their prime use is for servicing of groups of vehicles which have no specific winterization equipment.

It is the winterization kit which will be of most value to personnel operating vehicles in areas where the temperature stays below zero consistently. These kits are very complete and are designed for specific vehicles. Basic equipment included in a winterization kit includes a battery heater, a cab and engine-compartment heater, and also radiator and louver covers—all of which are permanent installations and thus are always ready for use with a minimum of preparation. Depending on the vehicle, there are numerous other items found in the various kits. Therefore, when requisitioning one of them you will have to look up the listing given in War Department Supply Bulletin 9-16 (SB 9-16), dated March 2, 1944, to find the number of the kit you must specify for your particular vehicle. This bulletin also lists territories for which winterization equipment will be furnished, so you will have to refer to it to find out if you are eligible.

Probably the best way to give an idea of the items you will find in the various kits is to cite a few examples of the equipment available for a number of different vehicles. The Chevrolet Bomb Service Truck M6, for instance, is supplied with a winterization kit which contains the following items: insulated battery box with heating coil, gasoline heater to heat battery, petcock for bottom of gasoline tank (for easy access to fuel used in the heaters), primer system, engine oil dilution system, crankcase ventilation system, radiator cover, electric windshield defroster, hot-water heater (foot warmer), 162-degree thermostat, fuel-pump diaphragm, tarpaulin, as well as an underchassis heater.

Before operation of the vehicle, it is necessary to warm the oil and the battery to a point where cranking is made easy. This is accomplished by means of the tarpaulin and underchassis heater which is placed under the crankcase, and the gasoline battery heater, located beneath the insulated battery box. The primer system then does its job of providing a rich fuel mixture which is injected directly into the intake manifold. The primer used here calls for installation of a new manifold designed to accommodate the primer nozzles. In addition, a new accelerator rod and a new metering rod are provided. In some cases, the addition of primer nozzles and a line to the manifold does not require installation of a new manifold.

During operation, the engine temperature is controlled by the 162-degree thermostat and the adjustable radiator cover, and the battery temperature is kept up by means of a hot-water heating coil under the battery and inside the insulated battery box. After operation, but before stopping the engine, the oil is diluted with gasoline by means of the engine oil dilution system. Thus, the oil is more easily kept in a fluid state. The crankcase ventilating system serves to take this gasoline out of the oil when the vehicle is next operated and the oil has become warm enough to flow as it should.

THE windshield defroster, the hot-water heater in the cab, the bracket for stowage of the underchassis heater on the running board and the straps for holding the tarpaulin when it's stowed away—all items that provide for the convenience or comfort of the operating personnel—may often be equally vital to efficient operation of the vehicle.

The winterization kit for the Chevrolet 4x4 contains much the same equipment as the kit for the bomb-service truck. The main difference is that an engine-coolant heater is provided instead of the underchassis heater. By starting this heater some hours before the vehicle is to be operated, the coolant is heated to a temperature which warms the engine sufficiently to make starting easier, in combination with use of the other cold-starting aids.

The type of heater provided in this case contains a small gasoline burner of the pot type which is fed by gravity from an auxiliary fuel tank. Air for combustion is furnished by the draft produced by a small flue, and installation of this flue, or stack, requires the cutting of a hole in the hood. Templates are included with the winterization equipment manual for use in installing this stack, as well as templates for the reserve fuel tank. This type of heater is lighted with a torch and may be burned continuously for periods of hours.

There is another kind of engine-coolant heater which operates in a somewhat different manner. In this type, the heater is controlled by an electrical switch from inside the vehicle, and the installation includes a fuel-pump unit for supplying fuel from the vehicle's fuel tank to the burner, a blower for supplying air for combustion, an ignition transformer to provide automatic ignition of the fuel, and a motor generator unit (operated by a storage battery) to drive the blower and fuel pump and to supply current to the transformer. Since this heater is much quicker acting than the one mentioned above, it should be burned only for periods of fifteen minutes at a time, according to instructions given in the manual. This is to prevent overheating. An added feature of this heater is its possible use in portable form as a winter aid in thawing out frozen brakes, tank treads or other parts, or in servicing vehicles not having heaters of their own.

TWO items not supplied for the vehicles thus far mentioned are included in the winterization equipment provided for the Diamond T 6x6 truck. One is the air-brake alcohol bleeder system which prevents freezing of moisture in the air-brake lines and valves by introducing alcohol into the air-brake system. The other is the set of metal louver covers for the fender shield and hood louvers.

The equipment installed on a tank or gun motor carriage is somewhat more elaborate. It includes a gasoline-driven motor with fuel tank, control box, and heater box. Heat is forced to the exterior of each of the lubricating-oil tanks and to the battery compartment through flexible tubing and ducts, and four shutter sections serve to retain heat in the engine compartment. The oil cooler is protected by a heavy fabric cover with a roll-up flap. Also included are air-intake and outlet shutter assemblies. In this case, as is true of some installations, it is necessary to make some changes in the wiring system. Miscellaneous equipment includes smaller items, such as plastic windshields for armored windshield slits, ice grousers, half-track idler scraper blades and brackets, and cut-out snowshoes for tractors.

Needless to say, the installation of winterization equipment, no matter how complete it may be, is not a panacea for cold-weather operating problems. Without the proper attention to other phases of operation, no equipment can be expected to perform effectively. Instructions in OFSB 6-11, "Cold Weather Lubrication and Service of Combat Vehicles and Matériel," must be faithfully followed in connection with the use of winterization equipment. This involves use of winter-grade gasoline and lubricants and checking of mechanical features to be sure they are all in proper working order.

Brushes, commutators, and bearings on the generator and starter must be clean. The large surges of current which occur when starting a cold engine require good contact between brushes and commutators. Wiring must be cleaned, connections tightened, and all electrical equipment must be kept free of ice. The distributor must be cleaned and points replaced and checked frequently. Spark plugs must be cleaned and adjusted, and timing must not be unduly advanced or retarded.

Batteries must be kept fully charged and care must be taken not to add water until the battery is to be put on charge, since added water will stay at the top and freeze before it can mix with the acid if the battery is not charging. Brake bands have a tendency to bind when very cold. Vehicles should be parked with brakes released and wheels blocked instead. Oil-lubricated speedometer cables should be disconnected at the drive end when the temperature is 30 degrees below zero, as they often fail to

RESULTS OF RESEARCH IN WAR CHEMISTRY

These Practical Products Have Been Developed through Research in Colloidal Chemistry and May Be Found Applicable to Your Business.

Self-Emulsifying Safety Solvent dilutes with water to replace naphtha, gasoline, or benzine for grease-cleaning, hand-wiping operations in metals processing plants. Contains no chlorinated compounds, has no flash or fire point and does not tend to defat the skin. (Data Sheet # 235)

Hydro-Sealed by floating water blanket, new high-performance Carbon Gum Digestive Solvent cleans carbon and paint from aircraft engine parts without harmful effect. Used hot, water seal prevents escape of solvent vapors. (Data Sheet # 236)

High-Potency Concentrate makes Self-Emulsifying Grease Solvent to remove insulating coats of grease and dirt from truck, jeep, tank and automobile engines by emulsification and utilizing the heat of a warm engine. Cleaned engines operate more economically since original thermal efficiency is restored. (Data Sheet # 237)

Unique Oil removes salt; may be applied to metal surfaces wet with sea water. Cleans, dehydrates and leaves thin film of rust-preventive compound. Suitable as a cleaner-preservative and lubricant for small-arms bore cleaning. (Data Sheet # 238)

High-Boiling Dehydrating Oil absorbs residual water from parts, storage tanks or equipment. Recovery for repeated use made by simple heating above 212° F. (Data Sheet # 239)

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New Fuel Concentrate raises low-test gasoline to high anti-knock rating motor fuel . . . especially applicable for high-compression motorcycle engines . . . increases performance. (Data Sheet # 241)

Sparkling Clear, water-in-oil cooling compound emulsion facilitates work inspections without stopping tools in metal-cutting and grinding operations. (Data Sheet # 242)

Emulsifying Compound cleans oil from camouflage paints; restores dead, flat, lusterless surface. Shipped as a concentrate. (Data Sheet # 243)

Instrument Shampoo emulsifying solvent cleans optical lens and delicate mechanisms without harmful effect. Results in physically clean work and complete absence of any film. (Data Sheet # 244)

Fluid, Pre-Paint Cleaning extracts and emulsifies all traces of wax, oil, and grease from hard surfaces. Rinses with water . . . leaves no film. (Data Sheet # 245)

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Gunk this versatile base concentrate when diluted with appropriate solvents anticipates every automotive, military, and industrial grease-cleaning problem. (Data Sheet # 248) Formulae available.

Write for Catalog and Engineering Data Sheets

Confidential formula bulletins will be made available whenever the particular purpose and use that the formula is to serve is described.

Gunk CLEANS CLEAN

Automotive Maintenance

work properly and sometimes break due to excessive drag caused by the high viscosity of the oil with which they are lubricated.

Operation of vehicles on hard, frozen ground causes strain and jolting which may result in screws breaking or nuts jarring loose due to the fact that low temperatures greatly reduce the shock resistance of metals. These items must therefore be checked regularly.

Storage of fuel also requires special attention. Due to condensation of moisture from the air, water will accumulate in tanks, drums, and containers. At low temperatures, this water will form ice crystals that will clog fuel lines and carburetor jets unless the fuel is strained. To prevent as much as possible the formation of ice in fuel containers, they should be kept as full as possible, since the more fuel there is in the tank, the smaller will be the volume of air from which moisture can be condensed. Addition of denatured alcohol to the fuel tank each time it is filled will reduce the hazard of ice formation. Closures of containers should be kept tight to prevent snow, ice, dirt, and other foreign matter from entering. Dispensing equipment must be kept clean.

There are many more important details covered in OFSB 6-11 with which you should be familiar, even to knowing that you should park a vehicle so it does not face into the wind, when there is no shelter available, to reduce chances of freezing. So remember to give your copy of OFSB 6-11 a good going-over.

The Care of Batteries

BATTERY care isn't particularly hard work—it's mostly a matter of faithful checking for cleanliness and the proper amount and condition of the electrolyte. A simple program of battery care involves the following steps: First of all, the operator of a vehicle should learn that the practice of running down a battery with the starter when the motor won't "catch" is sure-fire ruination of the battery. If the motor won't start promptly there is something wrong, and the source of the trouble should be located and corrected before further starting attempts are made. The starter should *never* be engaged for more than thirty seconds at a time.

Keeping the battery clean is especially important due to the fact that fumes from the electrolyte cause rapid corrosion. This is a pretty steady process, too, inasmuch as the fumes are always there, and a certain amount will escape through the filler-cap vent holes at all times. The carrier, as well as the battery itself, must be kept free from dirt and corrosion, and corroded terminal connections should be cleaned and then protected with a fresh, thin coat of grease. The cleaning process naturally involves checking of cables, vent caps, terminal bolts, etc.

Another check that should be made at least once a week is the hydrometer check of the electrolyte, which indicates whether the battery is properly charged. Wide variations in hydrometer readings of different cells indicate trouble, such as short circuits through separators, leakage of electrolyte through partitions between cells, worn-out plates in one or more cells, or badly contaminated electrolyte. In servicing the battery, distilled water is best, though water pure enough to drink will be found satisfactory. Acid should never be added except when the electrolyte has leaked or spilled out or when the battery has been overflushed. Adding acid to raise the specific gravity *does not* increase the battery charge, and it *does* shorten the life of the battery.

Naturally, the man who knows how batteries are constructed and how they work will be far better equipped to take care of them. So it's a good idea to be acquainted with the relatively new War Department Technical Bulletin, TB ORD 67, on storage batteries. This bulletin is easy reading, and it tells how batteries are constructed, how they work, and how they are maintained.

Foreign Armies

BRAZIL DEVELOPS A MODERN FIGHTING FORCE

BRIG. GEN. JOHN N. GREELY

THE South American Republic of Brazil has been moving rapidly to develop a powerful, modern, offense-minded army, able to take its place alongside the United Nations' fighting forces overseas. Building a highly mobile army for today's swift mechanized warfare is no easy job, as the Brazilians have found out. It is a long and herculean undertaking which demands the utmost in organizational detail, equipment, improvisation, training, and teamwork. The Brazilian general staff, mindful of lessons the allies have learned on the battlefield, is utilizing many of the latest techniques in preparing young Brazilians for combat.

Thousands of men called to the colors by the big southern nation are training now with some of the most modern war weapons. North American Lend-Lease assistance has provided much of the heavy material such as large-caliber guns and tanks. Brazil's industries and army arsenals have accounted for munitions and lighter army equipment. In general, Brazil builds what she can, imports the rest from the United States.

Modernization of the nation's army is entirely a Brazilian effort. It is the Brazilian general staff which organizes and trains the units and arranges for the delivery and assembly of Lend-Lease materials. The wartime emphasis now is on the maximum use of Brazil's vast natural resources in equipping the army. Thus, the booming industries of Sao Paulo, Brazil's Detroit, and Rio de Janeiro are turning out many of the instruments of war, like gas masks and field radio sets, which formerly were imported.

Dr. J. J. Moniz de Aragao, Brazilian Ambassador to London, recently declared that Brazil has 300,000 troops prepared for overseas operations. While no official War Ministry figures on the army's size have been released, it might be well to remember that, based on the 8 to 10 per cent military man-power estimate, Brazil could muster a large fighting force from its population of 43,000,000. Obstacles, however, lie in adequate modern equipment, cantonment areas, experienced instructors, and transportation. Like all nations which have changed over drastically from old-type theories of warfare, the Brazilians have had to learn the hard way. It is much more difficult, of course, for a country lacking in heavy industries to make the transformation, but the Brazilians have taken long strides forward. One of the most important factors in this has been the training of Brazilian officers in the United States, where they study the latest war methods and apply those lessons in Brazil.

Gen. Enrico Gaspar Dutra has played a leading rôle in the streamlining of the Brazilian Army. Since he became War Minister in 1937, the 65-year-old soldier has initiated many reforms in both army administration and tactics. His awareness of new developments in warfare, as borne out by reports from the fighting fronts, and his application of them to Brazil have earned for him a top place among Latin-America's military leaders.

In defending Brazil's strategic "bulge" area, Brazilian and American forces have been collaborating excellently. Officers report that a true spirit of camaraderie has grown up between the men of both countries. One of the big jobs of the Brazilian Army today is protection of the vital northeastern air and naval bases. Brazilian antiaircraft crews and troops, for example, ring all-important airfields, guarding against any possible attack. Some of the best equipped and best trained Brazilian forces are stationed in that area, awaiting further developments in the fight.

Hub of the Brazilian Army's training is Vila Militar, about fifteen miles from Rio de Janeiro, where draftees and young

The "RUSTY" SEASON

PEROLINE and DEOXIDINE

Eliminate Rust Bottlenecks

Humid, rainy summer months are rust months and play havoc with metal production. Vital supplies of war materials are delayed—at times stopped.

Rust bottlenecks no longer need occur to hamper production. Peroline and Deoxidine will eradicate and prevent rust, making these stoppages or delays unnecessary either in rainy seasons or at other times.

Peroline (a combined chemical and oil) not only effectively retards corrosion on steel components in processing, in storage and in transit, but—it dissolves blushes of rust, eliminating the labor of a separate cleaning operation. There is a grade of Peroline for application to wet surfaces as well as grades for application to dry metal. Peroline is unique in its ability to clean and, when the oil phase is removed with degreasing solvents, to leave the surface properly conditioned for painting.

Surface Badly Rusted. If in processing, surfaces have become badly rusted, Deoxidine provides a fast and easy means for removing and eradicating rust and rust stimulators, leaving a surface properly prepared for painting.

If you are experiencing rust troubles, the ACP technical department will gladly consult with you and recommend the method best suited to correct and prevent future rust annoyance.

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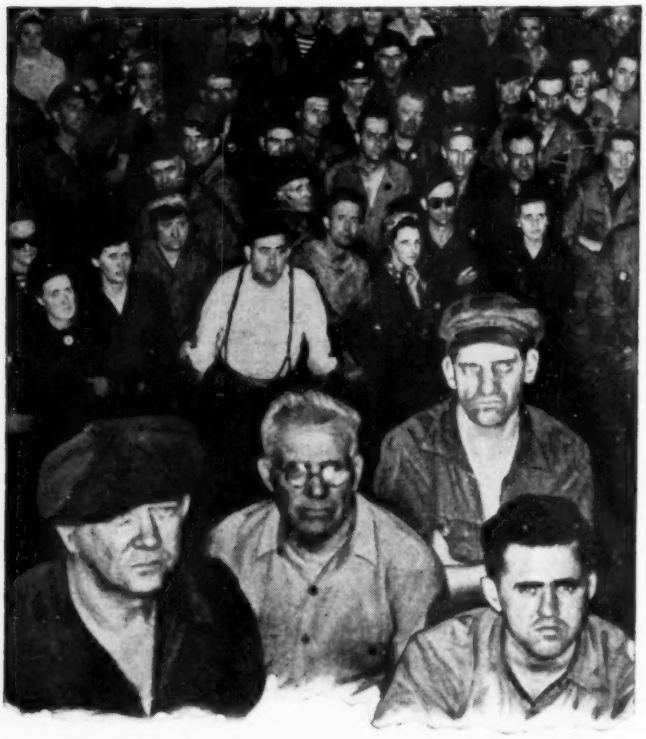

THE FIGHTING FACE OF FITZGIBBONS

Not a smile in the lot—just grim, stern determination to do their job in getting out armored equipment. The men and women of Fitzgibbons work in the blinding glare of welding torches, in the shattering roar of heavy shears, punches, bending rolls. Thus are born the M-7 Tank Destroyers whose 105 mm. guns are today making hash of the toughest enemy tanks, and thus were made many of the famous General Sherman tanks that are chasing Rommel out of France. In the making of these things the men and women of Fitzgibbons have earned the Army-Navy "E" award, with star for continued effort.

When the present need is past, the men and women of Fitzgibbons will again make steel heating boilers, and air conditioners. Their job is, first to make America safe—then to make it comfortable.

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Foreign Armies

officers are instructed in the infantry, artillery, signal corps, and motor-mechanization schools. Newest of these training centers is the motor-mechanization school (Escola de Moto-Mecanizacao), which boasts a wide assortment of tanks, scout cars, jeeps, and other up-to-the-minute war machines. Founded five years ago, the school first employed French and Italian equipment, but for the past two years modern American models have been the standard.

Students at this school enjoy working with modern equipment. Big 28-ton General Grant tanks and their lighter cousins, the 12-tonners, rumble across the training fields, ford creeks, and climb hills near the school as the Brazilians learn the mechanics of operating and servicing these fighting machines. Upon concrete ramps the tanks are given daily scrubbings by their crews before entering the shops for lubrication. The Brazilians take great pride in their mechanized units, as is evidenced by the careful attention they give them. The men love the compactness and power of the squat jeeps, the sturdiness and speed of the 8-man scout cars.

Only American tactics are taught at the school—by Brazilian officers who have studied at the U. S. Army's great Armored Force instruction centers at Fort Knox, Ky., and Fort Benning, Ga. Working with Uncle Sam's powerful land dreadnaughts in North America has kindled a keen enthusiasm among these officers which makes them eager to teach their fellow Brazilians what they have learned. Tank-training at the school lasts from eight to ten months, after which the tankmen are shifted to permanent field units.

A trip around some of the Brazilian Army camps now reveals the strong influence of the American military model. In general, the Brazilian Army is being organized by its leaders along the lines of the U. S. Army. Brazil was one of the first nonbelligerent nations to receive Lend-Lease assistance (July 1941), and, wherever suitable production facilities exist, the Brazilians are using American types as models in fabricating their own equipment.

Today the two traditional friends, Brazil and the United States, are joined as wartime allies. Their military, naval, and air collaboration is guided by the Joint Brazil-United States Defense Commission in Washington. In Rio are American Army officers serving on the Joint Brazil-United States Military Commission, which is an advisory body that makes general recommendations on modernization and technical usage of equipment.

Fighting side by side in mankind's toughest war, the Brazilian and American armies are ushering in a new era of friendship and close coöperation.

JAPANESE TANKS

JAPAN has at her disposal highly effective tanks, among other kinds of war equipment. Two types of medium and two types of small tanks mount cannon.

As a medium tank the Japanese employed, to begin with, the 11.1-ton Vickers M.K.C. tank which came from England and which is armed with one 57-mm. cannon and four machine guns and is heavily armored. Next, they developed from this the highly efficient 14-ton tank which is equipped with one cannon and two machine guns and which, according to *Deutsche Wehr*, was used as far back as the Chinese war of 1932 and is now again being used in the war against China.

The Japanese also used in the Chinese war a 7- or 8-ton tank, the Etsu, developed from the French Renault tank NC-27, which is armed in the revolving turret with two machine guns or with one machine gun and one armor-piercing cannon of small caliber. This tank is no longer manufactured, however, and has been replaced by a small Japanese tank with one cannon.

The Japanese also have a 3- to 4-ton tank, the M2592, which, according to Heigl, "The Pocket Tank Book," 1935, is equipped with one 20-mm. cannon in the turret and has a crew of two men. It has again been put to use in the present conflict.

Communications

Letters to the Editor are always welcome and will be published in ARMY ORDNANCE *whenever their content is of general interest to the membership. Communications for publication should be kept as brief as possible and should be signed by the writer.*

SCHOLARSHIPS FOR ORDNANCE RESEARCH

TO THE EDITOR—*Sir:* As a member of the Army Ordnance Association, I have a few suggestions that I believe would be of importance to the organization and a stimulus to further growth. First, I suggest that one article an issue be devoted to fundamental research development. The subjects would be on mechanical engineering, and the magazine would act as a channel for dissemination of research development for Ordnance done generally by civilian industry, though occasionally arsenals would be represented. Subjects selected would, of course, be of interest to both Army Ordnance and civilian engineers. There is hardly a civilian plant doing ordnance work that has not made unusual machine adaptations, clever jig, die, and fixture designs, together with many other novel and important departures from civilian practice.

Secondly, I suggest that another article each issue be devoted to applying some engineering, mechanical, machining, or other ordnance production development to civilian use. The aim would be to give certain definite clearcut developments to the Army Ordnance Association membership which they could use in return for their membership fee. As it now stands, the magazine is all any one truly gets for their dollars, and most of the subjects used cover things to think about, rarely to see, and never to touch, apply, or use. If a big interest is wanted in the Association, now is the time to get it, but I feel that in order to get and hold that interest, the members must get something more concrete in form. (See Editor's Note on next page.)

Thirdly, I recommend the institution of an Army Ordnance Graduate Training Program. Of course, this would have principally a postwar application, but I'm sure some real donations could be secured now for it while most people are in the giving frame of mind. In 1940 and 1941, one of the great needs of industry suitable for ordnance production was for scientifically trained research workers and engineers to direct their many new and unknown jobs. The Reserve officers were good in their places, but their places were not in the plants they knew all about, and few of them were properly fitted to direct production and understand ordnance engineering problems. The graduates of the training program could be known as Ordnance Production Reserves, and they would be Ordnance-trained on the graduate level. Engineering schools do an excellent job in undergraduate work, but the Army Ordnance Association graduate training would carry this educational process one step further and into a zone where the need was felt most keenly three years ago.

Specifically, fifty to one hundred picked college graduates would be trained yearly for masters' or doctors' degrees in chemistry, physics, mechanical engineering, etc., with ordnance specialization. A college or two, or the Ordnance arsenals, could be developed for the specialized feature. Upon completion of this training, the Association would have predetermined places for these men in private industries which had subscribed to the plan. The employer would allow such employees thirty days each year at an arsenal for research and development study.

Such a plan would tie industry much closer to Ordnance, and vice versa. Just imagine what it would have meant in time, money, and material if, in 1940, General Wesson had known in-

THIS ALVEY-FERGUSON Trolley Conveyor with pendant-type carrier hauls filled containers from remote parts of the building—at the most practical handling speed—and with uniform, safely spaced distances between containers.

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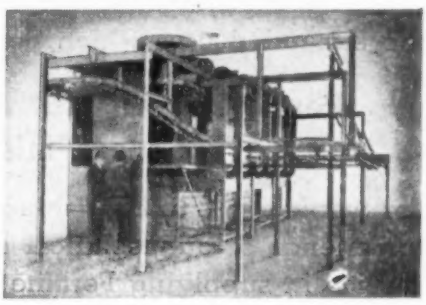

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Communications

dustry would be guided by the training, experience, and ability of, say, 2,500 Ordnance Production Reserves who thoroughly knew their shops and exactly what they could do and when.

MAJ. D. B. MACMASTER, *Ord. Dept.*

EDITOR'S NOTE.—*In addition to* ARMY ORDNANCE, *members also receive, at no extra cost,* FIREPOWER, *the Ordnanceman's journal, a bimonthly magazine about Ordnance personnel and matériel in battle;* ARMY ORDNANCE BULLETIN, *a Washington newsletter about current armament developments; and* ARMY ORDNANCE REPORTS, *issued as occasion provides, about topics of especial ordnance interest.*

UNIVERSAL PEACE

TO THE EDITOR—*Sir:* Reference is made to the May 15th Army Ordnance Bulletin (No. 43) quoting a former University of Michigan professor of history: "We will never have universal peace until the strongest army and the strongest navy are in the hands of the most peaceful nation." Being a University of Michigan alumnus, I do not hesitate to assail Prof. Van Tyne's statement as being patent nonsense. Let's see how it would work:

No nation in the world would admit that it was less peaceful than any other; therefore, every nation would have to strive for the largest army, navy, and air force. Result: an arms race, ending in international war to determine which nation is the most peaceful! Does that make sense to you?

We will never have universal peace until we have universal government. Any history teacher worthy of the name ought to know that. Therefore, I count myself fortunate that I did *not* study history under the late Prof. Van Tyne.

If you should ask how can we get universal government, I would refer you to the address of the Hon. Owen J. Roberts of the United States Supreme Court, as published in the *Congressional Record,* May 4, 1943. Justice Roberts proposes an international organization of the world's leading democracies in a federal union similar to our own Federal Government of forty-eight states. This federal government proposed by Justice Roberts could coöperate with the rest of the world within a league of sovereign states, admitting new states much as new states were admitted to our own Union.

CAPT. JOHN F. SCHMIDT, *Ord. Dept.*

A DEFINITION OF "CALIBER"

TO THE EDITOR—*Sir:* A number of men working for one of the naval architects in New York City would like a definition of the word "caliber," as defined by the Army. Is it a standard of measurement? What size would a .38 caliber revolver be? What is meant by a 5-inch, 50 caliber gun, and what is its size in bore diameter and over-all length? What is the relation of the "5-inch" to the "50 caliber"? Is there any difference in the word when used for small arms and big guns?

JEROME S. KOPLIK

EDITOR'S NOTE.—*The word "caliber" has two applications in ordnance and gunnery. It is used in referring to the diameter of the bore of a gun tube in inches—thus, a seacoast gun 6 inches in caliber. It is also used in referring to the length of the barrel of a gun measured by the diameter—thus, a 16-inch gun of 50 calibers; that is to say, a gun the diameter of whose bore at the muzzle is 16 inches, the length of whose barrel is 50 x 16 inches.*

When referring to the diameter of a barrel, it is customary to place the word "caliber" before the numeral when the latter is less than one inch; after it when the diameter is more than one inch. Thus we say a caliber .30 shoulder rifle but a 3-inch caliber antiaircraft gun.

From the Record

ORDNANCE ON THE NORMANDY BEACHHEAD

ONE of the things the layman doesn't hear much about is the Ordnance Department. In fact, it is one of the branches that even the average soldier is little aware of except in a vague way. And yet the war couldn't keep going without it. For Ordnance repairs all the vehicles of an army and furnishes all the ammunition for its guns.

Today, there are more vehicles in the American sector of our beachhead than in the average-sized American city. And our big guns on an average heavy day are shooting up more than $10,000,000 worth of ammunition. So you see Ordnance has a man-sized job. Ordnance personnel usually constitute about six or seven per cent of the total men of an army. That means we have many thousands of Ordnancemen in Normandy. Their insigne is a flame coming out of a retort—nicknamed in the Army "The Flaming Onion." (ED. NOTE: The Ordnance insigne is the bomb and flame—not a retort.)

Ordnance operates the ammunition dumps we have scattered about the beachhead. But much bigger than its ammunition mission is Ordnance's job of repair. Ordnance has 275,000 items in its catalog of parts, and the mere catalog itself covers a 20-foot shelf. We have scores and scores of separate Ordnance companies at work on the beachhead—each of them a complete firm within itself, able to repair anything the Army uses. Ordnance can lift a 30-ton tank as easily as it can a bicycle. It can repair a blown-up jeep or the intricate breech of a mammoth gun.

Some of its highly specialized repair companies are made up largely of men who were craftsmen in the same line in civil life. In these companies you will find the average age is much above the Army average. You will find craftsmen in their late forties; you'll find men with their own established businesses who were making $30,000 to $40,000 a year back home and who are now wearing sergeant's stripes.

You will find an IQ far above the average for the Army. It has to be that way or the work would not get done. You'll find mechanical work being done under a tree that would be housed in a $50,000 shop back in America. You'll find men working sixteen hours a day, then sleeping on the ground, who, because of their age, don't even have to be here at all.

Ordnance is one of the undramatic branches of the Army. They are the mechanics and the craftsmen, the fixers and the suppliers. But their job is vital. Ordinarily they are not in a great deal of danger. There are times on newly won and congested beachheads when their casualty rate is high. Our Ordnance branch in Normandy has had casualties. It has two small branches which will continue to have casualties—its bomb-disposal squads and its retriever companies that go up to pull out crippled tanks under fire. But outside of those two sections, if your son or husband is in Ordnance in France you can feel fairly easy about his returning to you. I don't say that to belittle Ordnance in any way, but to ease your worries if you have some one in this branch of the service overseas.

Ordnance is set up in a vast structure of organization the same as any other Army command. The farther back you go the bigger become the outfits and the more elaborately equipped and more capable of doing heavy, long-term work. Every infantry or armored division has an Ordnance company with it all the time. This company does quick repair jobs. What it hasn't time or facilities for doing it hands on back to the next echelon in the rear.

The division Ordnance companies hit the beach on D-day. The next echelon back began coming on D-day plus four. The great heavy outfits arrived somewhat later. Today the wreckage of seven weeks of war is all in hand, and in one great depot

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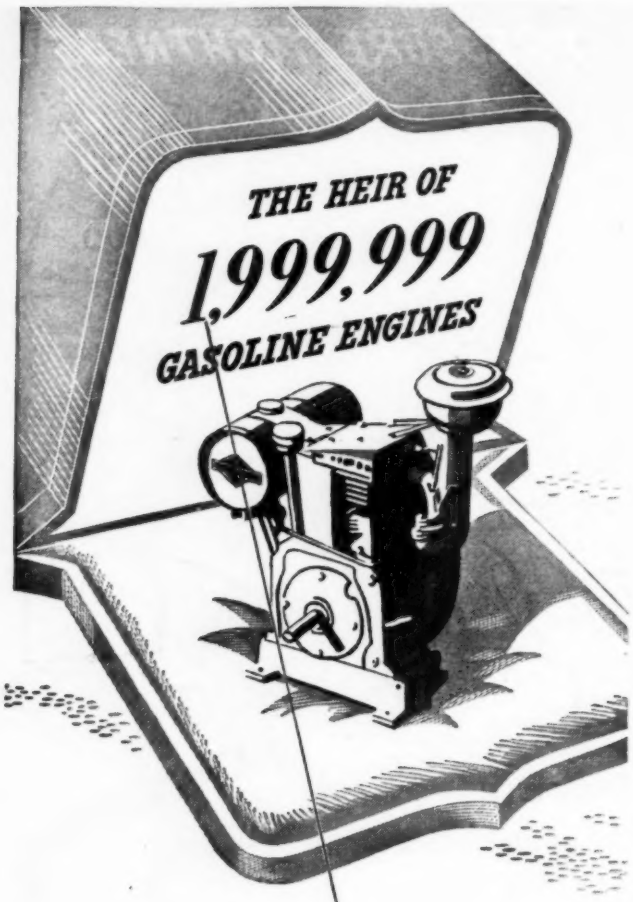

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From the Record

after another it is being worked out—repaired or rebuilt or sent back for salvage until everything possible is made available again to our men who do the fighting.—*War correspondent Ernie Pyle writing from the Normandy beachhead, as published in a United Features Syndicate article, July 25, 1944.*

Bernard Baruch—A Realistic Idealist

TONIGHT as we honor Bernard Baruch we are in truth expressing our belief in an American ideal, for he lives that ideal. As a free man, he treasures freedom for himself and for others, and in gratitude he devotes himself without limit to its preservation. In these days of war, when the democracy we live by is being tested to its core, he furnishes us a standard of unselfish devotion to his country. The patriotism of Bernard Baruch is not one of words; it is the tested patriotism of deeds. When America has needed his counsel, his genius, and the wealth of experience he brings to the solution of mighty problems, he has responded always in full measure.

I have come to know him as a man whose career is almost a paradox. Through some blending of human qualities, nature produced in him that rare product, a realistic idealist. Too often those who aspire to help their fellow men are lacking in the practicality necessary to the fulfillment of their good intentions; not so with Bernard Baruch. His is the genius of tempering aspiration with common sense. In his great work in the last war as chairman of the War Industries Board this quality of realism marked all his efforts. We in the War Department who have worked with him and been advised by him are greatly indebted to him for just such an approach to the solution of many problems. Coupled with his intuitive grasp of whether something will work or not is a breadth of vision that is prophetic. His knowledge of cause and effect, his understanding of why people do what they do, enables him to foresee events long before they are made apparent to all. . .

From his own sense of duty to his country he saw from the outset the necessity for our sharing our responsibilities in time of danger. The heart of democracy rests in that sharing and in the unity that stems from it. We recall that on the first page of the book in which Bernard Baruch gave his report on American industry in the last war he recorded a quotation from his chief, President Wilson, who said "The highest and best form of efficiency is the spontaneous coöperation of a free people." That coöperation is needed today as we enter the phase of this war that will call for heavy sacrifice on the part of our fighting forces. . .

The men who hit the beach on Atlantic or Pacific shores must know that back of them is all the power and might of a nation completely united in its acceptance of this war as *ours*—not theirs alone. In the past and in the present Bernard Baruch has accepted his country's fate as his fate, her tasks are his tasks, and to him long ago was given the wisdom that this must be so for every American.

As we fight tyranny and the threat of enslavement today, America becomes in great measure the hope of the world for the "promotion of good will and better understanding among all peoples." That hope will become reality if the standard for our measurement is the devotion and sense of duty that guide the man we honor here tonight. . .

When I went to the War Department four years ago to work on war production, I took time out first of all to study the work of Mr. Baruch in the War Industries Board of the last war. I promptly sought his advice, a course of conduct I have maintained to this day. With gratitude and with hearty affection, I acknowledge my personal debt to this great American.—*Hon. Robert P. Patterson, Under Secretary of War, at National Institute of Social Sciences dinner for Bernard Baruch, New York City.*

Ordnance in Review

THE GREAT GUNSTOCK "DISCOVERY"

ALBERT HERMANN

A RECENT issue of a national weekly magazine carried a pleasant fairy tale concerning "a big stockpile" of walnut gunstocks, usable for the present carbine, which had been unearthed by an alert industrial expediter at New Cumberland, Pa., and used to break "a serious bottleneck" in production. Then followed a weird story, in the best "Sunday-supplement" style, of these obsolete "German" stocks, palmed off as reparations payment after the first war by the astute Germans on a guileless Uncle Sam, and now, by a species of poetic justice, being used to kill the Nazi sons of those same Germans. Altogether it made engaging reading, but, unfortunately, the story doesn't hold water. The reasons for those gunstocks being found on the banks of the Susquehanna in 1944 are far more prosaic but perhaps no less interesting than the tale of their supposed origin in the Black Forest of Germany.

With the signing of the Armistice on November 11, 1918, all programs of arms manufacture, including caliber .30 rifles, were rapidly curtailed with the result that good American black walnut (*Juglans nigra*) gunstock blanks in numbers running well into seven figures suddenly became "surplus." It was realized by the Ordnance Department that replacement of this "treasury" of gunstock material *par excellence* might be virtually impossible, so it was decided by the Chief of Ordnance to salvage and store these gunstock and hand-guard blanks against a future need.

One of the principal caches was designated for Rock Island Arsenal, and by January 1, 1919, heavy shipments began arriving at that post. They came from a long list of suppliers, wholesalers, small-arms plants, etc. They proved to be in all stages of seasoning from kiln-dried to dead green, which meant that not only was storage required but also seasoning of the majority as well. In spite of Rock Island's large number of then-modern dry kilns, kiln drying was out of the question because of the avalanche of stocks that came down. Upon the writer, who was at that time dry-kiln foreman, fell the assignment by Col. Harry B. Jordan, commanding officer, of finding in available buildings a suitable location for the combined job of seasoning and subsequent storage of the stocks with a minimum of the degrade to which any green wood is prone.

The only feasible place was a one-story, steel-frame, monitor-roofed building sheathed with "wrinkled tin." Because the building was in excess of 200 feet wide, lateral circulation of air as a primary means of drying out the hundreds of tons of water present was impossible. Ideal storage space would have been not over fifty feet wide with ample but not excessive ventilation, and air changes through the piles would then have been possible largely through the effect of wind. However, efficient use of space in a 240-foot-wide building introduced many technical problems in the absence of forced ventilation.

AFTER considerable scheming, a plan of piling was devised which utilized the strong tendency toward vertically downward circulation in piles of green lumber for the principal flow of air. Provision had to be made for the access of fresh air through the roof and for the escape of moist air at the floor line. The former was accomplished by removing some of the glass from the monitors and replacing it with wood louvers, and the latter by cutting off with a torch the corrugated sheathing all around the building some three feet above the ground. Thirty-six-inch-

Mr. Hermann is in charge of the research laboratory of the Western Pine Association, Portland, Oreg.

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It's the operating slide of the latest type Carbine Rifle—a most important part. It has to be finished accurately and to fit perfectly into component parts.

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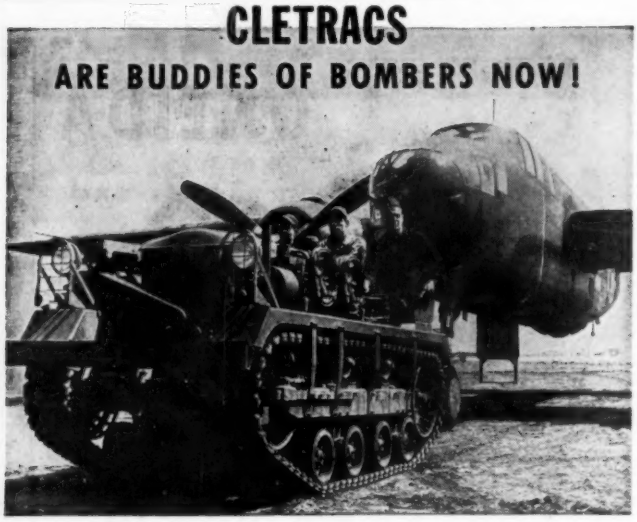

Office of War Information photograph

Squadrons of bombers can take to the air more quickly because of Cletrac's help in moving, arming, fueling, and servicing them for another "Berlin Blockbuster." Every member of ground and flight crews really values the constant help Cletracs give their Buddies, the Bombers.

Servicing planes is only one of many ways in which Cletrac is aiding the armed services with special tractors. Both in this country and abroad Cletracs of all types have transformed forests, swamps, and desert wastes into flying fields and bomber bases. Regardless of climate and soil conditions Cletracs have tackled and licked the tough jobs of building supply and access roads.

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Ordnance in Review

wide "chicken wire" kept out rabbits and wind-blown rubbish. With pile foundations eighteen to twenty-four inches above the ground, and adequate vertical air passages, slow but positive air drainage was achieved which resulted in seasoning almost without degrade.

To provide access in the event of fire, the piles of stocks were made about twenty feet square with 4-foot aisles in both directions clear through the building. To achieve unrestricted vertical air passages, the first course of stocks in each pile was accurately spaced on the foundations with a "layout stick," and the piling crews were trained to superimpose each successive stock vertically "in line" with that in the course below. Crosser strips of dressed one-inch lumber provided four lines of support for each stock to prevent warping. Temporary vertical guides at the corners of the piles, consisting of two boards nailed in the form of a trough and plumbed in two directions, completed the nice geometrical arrangement. Thus were the needs of both science and of "military smartness" served.

When several hundred thousand stocks had been so piled and their satisfactory seasoning progress established by numerous samples, an inspecting officer from the Office of the Chief of Ordnance requested Colonel Jordan to send "whoever was responsible for this job" to New Cumberland Army Reserve Depot to lay out a storage plan and organize the piling of some three million stocks and an equal number of hand-guard blanks designated for storage at that post.

The result was two trips to New Cumberland, the first to modify the storage buildings and design the foundations, the second to train and start off the piling crews. To all intents and purposes, storage at New Cumberland was identical with that at Rock Island. At the peak, some thirty-five cars of stocks daily were delivered. Among these were about 750,000 which had been in temporary storage in a lot of small unsuitable buildings at Fair Oaks and Seven Pines, Va. The rest came from all over the country.

For a number of years after piling this walnut, it was inspected both at Rock Island and New Cumberland by representatives of the U. S. Forest Products Laboratory and the Bureau of Entomology to check on the satisfactoriness of the seasoning and freedom from borers. In the light of these facts, let's not credit Nazi forebears with unloading a lot of obsolete stuff on us. Those good gunstocks were at New Cumberland in 1944 because the Ordnance Department had done its job in 1919 and in subsequent years.

THE ORDNANCE INSIGNE

THE insigne of the U. S. Army Ordnance Department—"the shell and flame"—is the oldest military device of the American Army. It was adopted by the Department in about 1833 and ever since that time it has officially designated this branch. Antecedent to its American adoption, the insigne had been used by the British Grenadier Guards, Royal Engineers, and Royal Horse Artillery. After its adoption by the American Army, it was used by the Artillery, as well as Ordnance, until 1834 when the traditional crossed cannon was adopted by the Artillery.

The Ordnance seal (crossed cannon in circle with "shell and flame" above) from 1833 appeared on all Ordnance publications, documents, and drawings. At the present time it is the official seal of the Ordnance Department and is known as the "Ordnance escutcheon."

The "shell and flame" (called also the "flaming bomb," and "bursting bomb") is designated the official insigne of the Ordnance Department by Army Regulations 260-10 and 620-35. In August 1930, an Ordnance Order designated the "shell and flame" as the "Ordnance insigne." At present, the insigne is worn as a part of the official uniform for Ordnance officers on each lapel of the blouse.

Professional Digest

SMALL ARMS INDUSTRY INTEGRATION COMMITTEES

INDUSTRY integrating committees, organized by Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, are performing many valuable functions in this war. Through these committees, the armament and ammunition manufacturing wisdom of the old-line Ordnance arsenals is made available to new contractors without cost. Inventories of raw material, semifinished and finished parts, together with production training for key machinists and assemblers, enable the new contractor to start production with a very real amount of "know-how."

This form of integration has made it possible to get production started in only a fraction of the normal time required; has made it possible to obtain millions of items from hundreds of small contractors in complete harmony with a smooth integrated flow of production. This form of coöperative procedure is being used successfully for all the items throughout the entire range of Ordnance components up to and including large and complicated fire-control directors.

The work of the Small Arms Industry Integration Committees during the past year may well serve as a practical example of how the Ordnance Department is able to secure maximum production of the highest quality at the lowest cost.

Twelve small-arms committees, comprising 121 member-companies, smashed manufacturing bottlenecks, maintained required schedules, stabilized procedure and production methods, integrated production experience, and standardized both material requirements and the interchange of components and material during the period July 1, 1943, to June 31, 1944. The highly fruitful activities of these twelve committees will now be considered in more detail.

In the small-arms ammunition field, six member companies operated three company-owned and twelve Government-owned ammunition plants at full capacity on July 1, 1943. These 15 plants employed up to 178,000 workmen and were producing at a rate of 80,000,000 rounds of ammunition a day or approximately 2,000,000,000 rounds a month. The total production of small-arms ammunition during the entire first World War was only a little over 3,000,000,000 rounds. Manufacturing methods and procedures were streamlined at all plants through standardization of machinery and equipment. All information relative to supplies of equipment and material, as well as prices and schedules, were cleared through the committee. This covered over 26,000 individual prices with an approximate value of $150,000,000.

Another outstanding service performed by the small-arms ammunition industry and its committee was the temporary conversion to steel ammunition. As a result of exhaustive studies and experiments, successful production was achieved in fair quantities. Toward the end of 1943, however, brass again became available in sufficient quantities to obviate the necessity of further steel ammunition production.

The flow of ammunition to the using services and into field storage depots so far exceeded immediate requirements that it became necessary during the latter part of 1943 to close down nine of the fifteen plants or to reconvert them to their previous production.

The Carbine Committee faced a most difficult production problem of a critical weapon which had never before been produced in volume and on which specifications and drawings had not been coördinated with production processes necessary to volume manufacture. Despite these difficulties, the rapid increase in deliveries of carbines set an unequaled record. From a total

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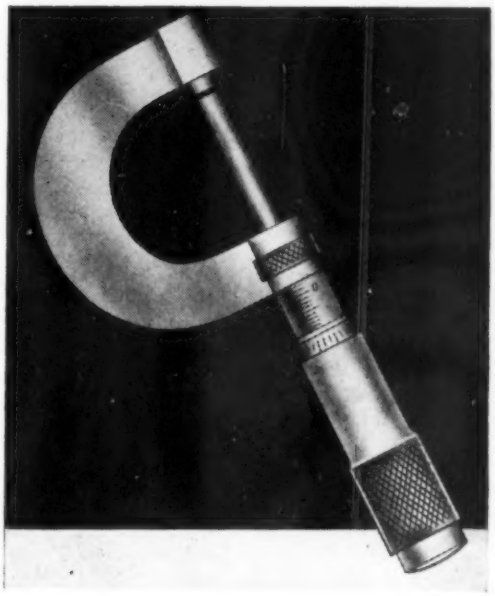

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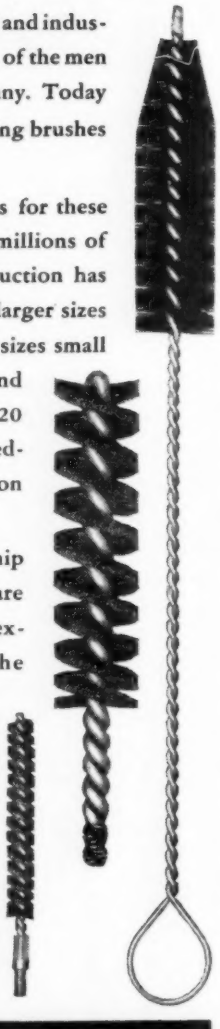

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Professional Digest

of 40,000 guns in February 1943 production increased to over 500,000 a month in November and December. As an example of real integration, the Carbine Committee, up to April 15, 1944, exchanged 4,334,870 parts and 2,094,578 pounds of steel.

A plan which contributed much to the success of rapid carbine manufacture was the concentration of barrel production at certain plants and the distribution of these barrels, through Government-free issue, to other plants. With the reduction in 1944 carbine requirements, all but two contractors were terminated in April 1944. Accordingly, the committee was placed on an inactive status as of May 1944.

THE activities of the Machine Gun Committee have been least affected by changing requirements, though there were changes in types which necessitated the readjustment of plant production. The committee maintained virtual capacity production on five models for nearly two years. During 1943, schedules were so arranged as to limit the production in each plant to one type of machine gun. This contributed much to the even flow of guns of various types to meet requirements. The committee took full advantage of its authority to integrate component parts and materials in order to break a series of serious production bottlenecks. Up to April 1944, the committee arranged the exchange of a total of 5,314,848 components and parts, and 4,487,145 pounds of material. This coördination of facilities made possible the delivery of a steady supply of between 70,000 and 75,000 guns a month.

Definite procedures set up during the year for handling engineering changes in both the carbine and machine-gun committees most effectively speeded up and clarified production directives. These procedures assured control of specifications by the branch engineering section, permitted review of suggested changes by all members, and provided a sure and speedy method for officially putting into effect approved changes through proper channels. It has been noted that the functioning of this procedure not only made possible the answering of many production difficulties within the respective committees but tended greatly to reduce the number of requests for changes.

The Metallic Belt Link Committee, originally representing twenty-nine facilities, had the largest membership of any small-arms committee. From September 1943 through January 1944, in response to urgent demands, over 500,000,000 caliber .50 links were delivered each month. The flow eventually became so great that it was necessary to cut back production in line with requirements. With the complete discontinuance of caliber .30 link production and an eighty per cent reduction in caliber .50 link requirements, all but nine facilities were terminated as of March 1944.

The Rifle Committee, originally organized to include the manufacturers of all types of rifles, was subsequently reduced to include only those facilities interested in the 1903 Springfield rifle. Engineering and production on the Garand were concentrated in Springfield Armory. As there was only one facility in the United States and one in Canada manufacturing the Lee-Enfield rifle, a special committee was organized for this weapon. The manufacture of the Springfield required considerable attention because production was first instituted without satisfactory drawings and specifications. When this problem was solved in December 1943, it was decided that production of the rifle would be discontinued. Accordingly, the committee was disbanded as of December 1943.

The Bullet Core Committee successfully worked on problems peculiar to cores and solved many production difficulties. With the reduction in small-arms ammunition requirements, the need for this committee declined, and it was placed on an inactive status as of February 15, 1944.

When the Clad Metal Committee was organized in March 1943, the copper situation was critical, necessitating the use of

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clad metal for bullet jackets. The committee was very active until October 1943, when the entire situation changed, due to the availability of copper. The committee was disbanded in November 1943.

The M1 Clip Committee was extremely active up to June 1943 and solved many production problems. When requirements for the clip were substantially reduced, the committee was disbanded in August 1943.

The Pistol Committee successfully expedited the manufacture of the caliber .45 automatic pistol which was in considerable demand by the using services. As this item had never been mass-produced, considerable modification, particularly of drawings, was necessary. At the present time, there are three facilities delivering complete weapons and one other producing caliber .45 pistol barrels only.

The Bayonet and Trench Knife Committees, due to stabilized production and reduced requirements, have been on an inactive status since January 1944 but are sometimes convened for consultation by the hand-arms equipment branch of the Office of the Chief of Ordnance.

The twelfth committee, the Ammunition Box Committee, was organized in January 1943 and originally had sixteen members, of which ten were smaller war plants. It took many of these small plants an unusually long time to get into production. At present, production of the caliber .30 M1 box has been discontinued. Requirements for the caliber .50 M2 box, however, have increased and all facilities have been placed in full production for the balance of 1944.

New Light Bombardment and Fighter Planes are Now in Production

A NEW light bombardment plane, the A-26 Invader, described as an improvement of the A-20 Havoc which has been so widely used in combat operations, is now in production by the Douglas Aircraft Company.

The Army Air Forces also is obtaining a new fighter plane, the P-63 Kingcobra, described as a larger and improved version of the P-39 Airacobra which has been in use since the early days of the war. The P-63 is a product of the Bell Aircraft Corporation.

The AAF has also revealed that the jet-propulsion plane produced by Bell Aircraft Corporation and powered by General Electric-manufactured engines has been designated as the P-59A. The jet plane has been given the name "Airacomet."

The recently announced P-61. Black Widow night fighter in production by Northrup Aircraft, Inc., now can be described as powered by two 2,000-horsepower Pratt & Whitney engines and equipped with 4-bladed Hamilton Standard propellers. This twin-fuselage, twin-tail craft weighs over 25,000 pounds, is armed with 20-mm. cannon and caliber .50 machine guns, and carries the latest night-fighting devices. It has long range and effective speed and climb characteristics and carries a crew of two or three men.

The B-29 Superfortress Bomber

DESPITE its sensational and effective attacks on Japan, a thorough test in battle still lies before the B-29 Superfortress—America's largest bombardment airplane. It is the most complicated flying mechanism ever assembled by any nation, and many of its innovations are now receiving their first test. Use of the plane must be confined for many months to sporadic missions, and many problems of bases, training, production, modification, and supply must be worked out before its full power may be exploited.

Quick... sure method for installing insulation!

Photos courtesy Pacific Huts, Inc.

Insulation batts which are so necessary for protecting military huts against Alaskan and Aleutian weather are held in place with a 3-M Adhesive. The above illustrations show ribbons of 3-M Adhesive laid by a caulking gun in the construction of "Pacific Huts". The 3-M Adhesive used on this job was especially compounded in our laboratories to hold insulation batts in place regardless of outside weather conditions.

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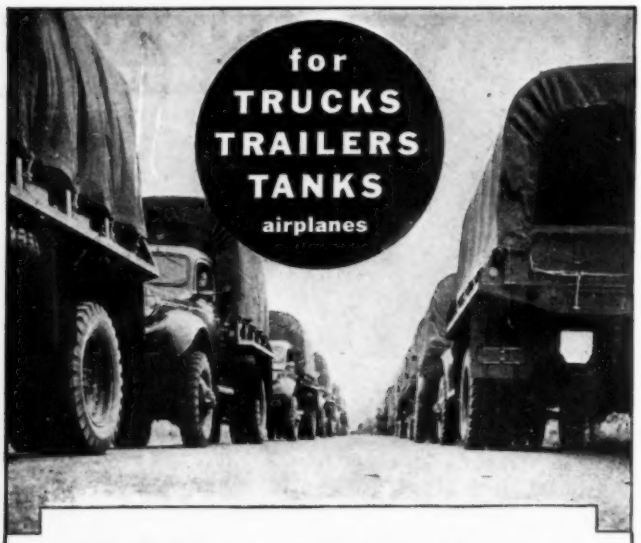

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Professional Digest

The Superfortress has a wingspan of more than 141 feet, is almost 100 feet long, and has an over-all height of more than 27 feet. It is 1½ times as large as the B-17 and has engines almost twice as powerful. It carries a greater bomb load, is far faster, has greater altitude and longer range than any other bombardment plane in the world. It bristles with caliber .50 machine guns and 20-mm. cannon. Its wing, of completely new design, has the highest coefficient of lifting ability to speed of any wing. Its 16-foot, 4-blade propellers are the largest on any aircraft. It is flush-riveted and butt-jointed throughout. (See illustrations on page 294.)

The plane is long and cylindrical, with an elongated nose extending well ahead of the wing. It has a single fin and rudder similar to that of the B-17. A double-wheel type of gear, both for the main landing gear and the nose gear, supports the B-29. The pilot and copilot, with the bombardier in front of them, occupy the same compartment in the tip of the nose of the plane.

The B-29 is being built at the following five plants: Boeing at Seattle and Renton, Wash., and Wichita, Kans.; Glenn L. Martin Company at Omaha, Nebr., and Bell Aircraft Company at Marietta, Ga. The Fisher Body Division of General Motors Corporation has a major part in the fabrication of subassemblies.

The B-29 engines are 18-cylinder, radial, air-cooled, 2,200-horsepower Wright Cyclones, designed by Wright Aëronautical Corporation. They are built by Wright and by the Dodge Division of the Chrysler Corporation. In addition, hundreds of subcontractors are participating in the production of the Superfortress.

The Superfortress protects itself from enemy fighters with a new system of remote fire control whereby gunners direct gun turrets from comfortable, strategically located sighting positions.

In the B-29, for the first time in aircraft, the sight and guns have been separated by some distance, making possible a wide choice of locations for both guns and gunners.

Through this latitude in selecting spots for the turrets, it is possible to give a wider arc of fire and to arrange for concentration of firepower. At the same time the gunners can be in positions of best visibility for covering the areas assigned to them.

Pictures of the Superfortress shown thus far have not disclosed the locations of the multiple caliber .50 machine-gun turrets or the 20-mm. cannon.

Remote fire control is almost necessary in a pressurized bomber such as the B-29. The crew rides in heated cabins having pressures equivalent to about 8,000 feet altitude, even though the plane may be several times that high. The pressurization problem was greatly simplified by having the turrets outside of the cabins. Should a shell puncture the cabin, the crew members don oxygen masks which are also worn during a bombing run as a precaution against possible interruption. Crew members also plug in the electric cords of their heated flying suits while the cabin is thus depressurized. If the cabin remains sealed it can be pressurized in an instant by opening an intake valve connected to the turbosuperchargers, and oxygen masks and heated suits are no longer necessary.

Allison 3,000-Horsepower Aircraft Engine

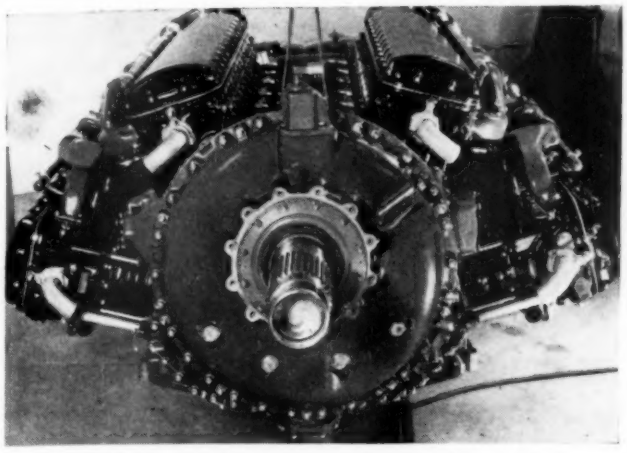
THE most powerful aircraft engine in the world, which will increase the engine power of the majority of single-engine aërial fighters by several hundreds of horsepower is now being manufactured by Allison Division of General Motors for the U. S. Army Air Forces. The new engine has maximum ratings approximating 3,000 horsepower.

When the new Allison liquid-cooled engine successfully underwent tests at Wright Field in June 1943, it was rated the most powerful ever to pass those rigid tests, and the horsepower has

Professional Digest

been increased since then. Installation of the new engine in aërial fighters still on the secret list will make United States fighting planes possessors of the greatest striking power of any aircraft anywhere.

The new Allison, which is designated as the V-3420 series, is a 24-cylinder, liquid-cooled engine. It has exactly twice the piston displacement of the present standard Allison 12-cylinder



THE 3,000-HORSEPOWER ALLISON ENGINE

engine which powers such famed American fighting planes as the Lockheed Lightning, the P-51 Mustang, the A-36 Invader, the Airacobra, and the Warhawk.

Early mass production of the new engine at Indianapolis is assured because, through simplified designing in the power section of the new motor—which is the heart of the engine—ninety-seven per cent of the piece parts are interchangeable with those of the present Allison.

THE "WEASEL"—NEW ARMY VEHICLE

THE "Weasel," a new personnel or supply carrier for reconnaissance over snow, mud, or other treacherous terrain, now is in full production and has been used successfully in the invasion of France. Known officially as the Cargo Carrier M29, the Ordnance full-track-laying conveyance has been nicknamed the "Weasel" because of its ability to travel stealthily and swiftly. Particular attention has been paid to artifices of concealment.

The body of the new vehicle is low-slung, oblong, and square-cornered. Without its demountable canvas top and windshield, the Weasel is wider than it is high. The width measurement of sixty inches is more than half the length. The driver sits immediately behind the flat front, with the instrument panel at his right elbow and the engine beneath the panel. Space at the rear accommodates three passengers or cargo, depending on the mission of the vehicle.

AIRPLANE ROCKETS

DIVE bombers in the China-Burma-India theater are using Army Ordnance rockets—"flying bazookas"—with deadly effect against all types of ground, sea, and air targets.

When first employed in the Far East, the rocket installation was made so that bombs or rockets could be carried but not both at the same time. It normally required forty-five minutes to shift from bomb racks to rocket racks or vice versa. The rocket installation was then changed to the wings, leaving the bomb racks intact.

Today, U. S. aircraft squadrons have flown with many com-

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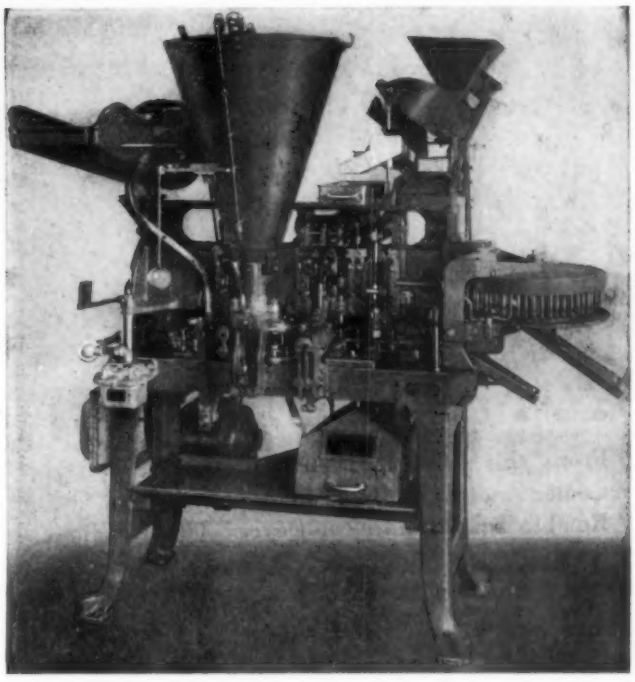

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For Caliber .30 Cartridges

One of our large family of Small Arms Ammunition Machinery. This line is the outgrowth of long experience in the development of machinery for the mass production of bullets, cartridge cases, etc., and the handling of explosives.

While the equipment is used extensively in U. S. Government Arsenals, the line includes also various machinery adapted to the manufacturing practices of England, Canada and other foreign countries.

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These big "71's," installed in food storage depots in every war theater, help keep American soldiers the best-fed in the world. And for Quartermaster Corps installation in portable refrigerators for freight cars, Army trucks and shipboard use, portable UCC refrigerating units now are rolling along the way that eventually leads to Berlin and Tojo's back yard.

Universal Cooler has contributed other military production to our "invasion arsenal": water chests and pumps for cooling 50-cal. A.A. guns, tank gun traversing mechanisms, and supercharger lubricating pumps for bombers.

Universal Cooler men and women will continue to do their best to help our fighting forces — to place Victory first until the job is done.

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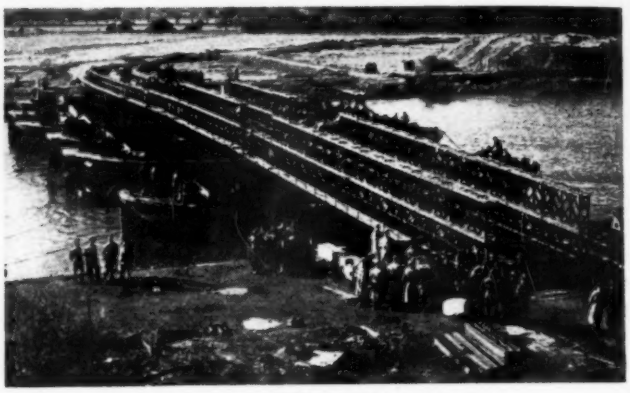
Professional Digest

binations—depth charges and rockets, extra gasoline tanks and rockets, 500-pound bombs and rockets, and 1,000-pound bombs and rockets. A tremendous increase of striking power was thus added to the fighter planes by enabling them to carry both bombs and rockets—an ideal combination for attacking ground targets.

Rockets have a big advantage over the same size guns, since the launchers are light in weight and there is no recoil or kick. This makes them especially adaptable for use on fighter planes. Fighter planes now using the new weapon include the P-40 Warhawk, P-47 Thunderbolt, P-38 Lightning, P-39 Airacobra, and the P-51 Mustang.

The Bailey Bridge Spans 240 Feet

DESCRIBED as the most remarkable bridge in military history the British-designed Bailey bridge, quick-assembly spanning device which is now speeding the movement of United States and British armies into Europe, can cross any gap up to 240 feet without pontons. With pontons it can bridge much wider gaps.



THE BAILEY SINGLE-SPAN BRIDGE

In its lightest form, the Bailey bridge is known as "single span" and can carry twenty tons. Its construction can be doubled or trebled to carry the weight of the heaviest tanks. Called the "panel" bridge by Americans, the Bailey bridge is now also standard U. S. Army equipment, and component parts manufactured in both Britain and the United States are completely interchangeable.

The bridge fits together like a gigantic jigsaw puzzle. There are no nuts or bolts and only one steel pin is needed for each "join." Sections are ten feet long and are composed of seventeen parts. Nine other parts are used to make the foundation. Six men can handle the heaviest part with ease. The Bailey bridge is first built on rollers on the bank of a gap and then pushed over by the building crew without mechanical aid. Sections are erected and rolled forward until the gap is completely bridged.

Rocket Powder

THE supply of rocket powder will be materially increased the latter part of 1944 when a $24,000,000 addition to a Hercules Powder Company-operated Ordnance plant in Wisconsin—Badger Ordnance Works—is completed.

So vital is the production of rocket powder that the Army has placed it on the critical list ahead of planes, aviation gasoline, tanks, and ships. Rockets have proved an important factor in the capture of several Pacific islands by the Marines at a considerable saving of lives. The new propellant is now being produced at Hercules-operated Sunflower Ordnance Works in Kansas, and production is continually being increased.

Book Reviews

ROCKETS. By Willy Ley. New York: Viking Press. 287 pp. $3.50.

WILLY LEY is no stranger to nontechnically trained readers of works on technical subjects, in other words, to the layman. His little volumes, "Bombs and Bombing," and "Shells and Shooting" were godsends to those anxious to be informed upon these subjects without having to acquire degrees in chemical and mechanical engineering en route. His present work, although demanding somewhat more familiarity with mathematics and physics than its predecessors, remains distinctly an offering to the man in the street and an extremely palatable and digestible one at that.

To disabuse all and sundry of the idea that Ley has written a book on rocket warfare, let it be explained that less than two pages of this volume are devoted to discussions of the rocket weapons of World War II. Its subtitle, "The Future of Travel beyond the Stratosphere," indicates very clearly its scope and means exactly what it says. It is nevertheless highly probable that many will secure copies expecting to be regaled with the details of construction and operation of the "bazooka" and its counterparts, great and small, throughout the armies, navies, and air forces of all warring nations. Such persons are doomed to disappointment, since most of this information is secret or confidential and is likely to remain so until the close of the war.

But for him who would know the history of man's attempts to reach above and beyond the layer of atmosphere which surrounds this globe and the chances, based upon the present state of knowledge, of his being able to send "space ships" to the moon, Mars, or Venus—or even to engage in such flights himself and return to tell the tale—Ley has produced a scholarly and well-documented story. He makes no attempt to brush aside the insuperable obstacles which presently inhibit success in this field. But he unfolds his arguments in favor of *eventual* success so logically, so simply, and so convincingly that many of those who approach his little work in the same spirit in which they might open a treatise on "Dr. Curem's Magic Snake Oil—A Panacea for Man and Beast," will lose much, if not all, of their skepticism ere they reach the closing pages.

HITLER'S GENERALS. By W. E. Hart. New York: Doubleday, Doran & Company. 222 pp. $2.75.

THE author, a former German officer, knew firsthand the nine men described in this book, having served with most of them under the Weimar Republic. He tells the details of the vicious life-and-death game for world domination they played among themselves. Rommel is not a good general, but a sly politician and a complete show-off. Von Fritsch, former army head and military genius, was not killed in action in Poland as reported but was murdered by Storm Troopers. Von Runstedt has the finest military mind in Germany. Von Brauchitsch, is shown as a general of great ability. Keitel, a military "yes man" who is known to other leaders as the "comic-strip general," Von Bock, a second-rater, and Milch, founder of the *Luftwaffe*, complete the army men. Doenitz and Raeder are the naval officers described.

Nazi upstarts pitted against old-line warriors and the Gestapo against the army, battle in this struggle for power. The author served with the British in this war and at present is military correspondent for several English newspapers, writing under the pseudonym of Hart. In view of the recent developments in Germany and the uprising among the old-line generals, this book is of particular interest to the military reader.

Comparative service tests continue to prove convincingly that Kennametal lathe files multiply production, improve quality of work, and effect substantial savings in the cost of files used. For example, on the job illustrated above:

A mill cut steel file, employed to remove the sharp edges from the 400 Brinell steel part, wore out on about 100 pieces. A Kennametal file turned out 800 pieces the first day—stayed on the job two weeks—and produced 15,000 pieces. The Kennametal file cut a curling chip—did not scrape or skid—and provided a finish that was almost as smooth as a grinding job!

Kennametal lathe files outlast steel files 50 to 200 times, because their surface is made of the same hard, cemented carbide composition as steel-cutting Kennametal-tipped tools. They permit filing speeds 3 to 10 times those possible with steel files—doing an outstanding job on cast iron and brass at surface speeds around 900 feet per minute, and on high-carbon, high-chromium steels at 800 surface feet per minute. The keen, sturdy teeth of a Kennametal file will make a clean, true cut on steels up to 62 Rockwell C, a hardness that ordinary files cannot touch.

The value of any tool is measured by the quality and quantity of work it produces. The higher original cost of Kennametal lathe files is insignificant compared to the tremendous economies effected through their use. Order one today for test purposes—let it prove its merit in your shop.

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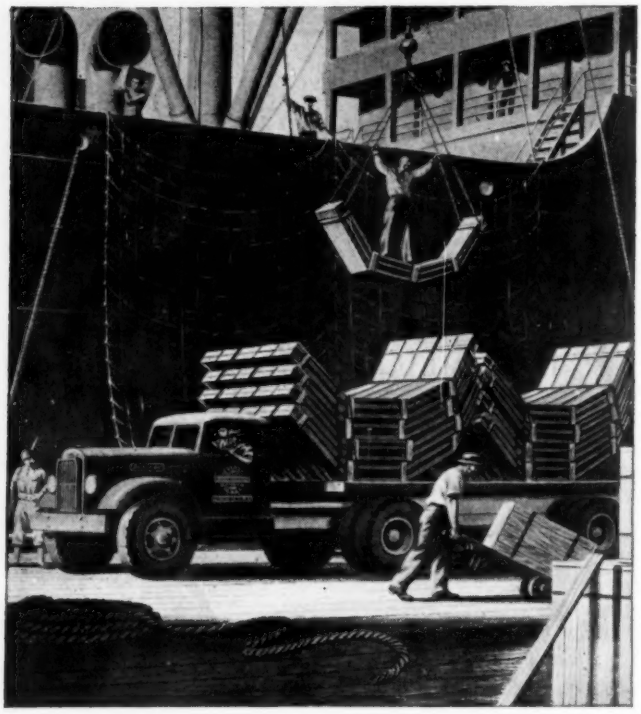
Kennametal Lathe Files are now furnished in two sizes—11" or 14" long—and each size is available with either 20 or 30 teeth per inch. The 11" size (F-76, 30 teeth/inch; F-77, 20 teeth/inch) having a filing surface 4" long x ¾" wide, costs $12.50. The 14" size (F-86, 30 teeth/inch; F-87, 20 teeth/inch) having a filing surface 6" long x ¾" wide, costs $18.50. All sizes can be shipped promptly.



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FOR EXCELLENCE OF PRODUCTION

Book Reviews

EISENHOWER—MAN AND SOLDIER. By Francis Trevelyan Miller. Philadelphia: The John C. Winston Company. 278 pp. $2.

THIS book is an excellent biography of the great military genius who is leading the AEF in the drive on Nazi Germany. Born of German parents who came to the New World to escape wars and religious persecutions, he is fighting for the liberation of the peoples of Europe who have suffered the blows of the Axis machine.

Gen. Dwight D. ("Ike") Eisenhower was born October 14, 1890, in Denison, Tex. Moving to Kansas at the age of two, he grew up as a typical American boy in a typical American town. He exhibited leadership and assumed responsibility at an early age, developing those qualities of great courage and initiative for which he is noted today. He was an excellent athlete in his school years and, being intrigued by biographies of great military leaders, chose to serve his country in the Army. Entering West Point in 1911, he received his commission in the infantry and was graduated in 1915, starting on a brilliant and unparalleled career. Organizing the first tank corps in World War I, he was ready to sail for France with his tank unit only to receive the news, disappointing to say the least to this new officer, of the signing of the Armistice just as he boarded a transport.

One can readily understand the tremendous store of military knowledge that is his when consideration is given to the numerous assignments he has held in Army posts and camps in this country and abroad. He served in the Panama Canal Zone and with General MacArthur in the Philippines. As a staff officer, he served at the War Department in Washington, at the Command and General Staff School, Fort Leavenworth, Kans., and the Army War College and Army Industrial College, Washington, D. C.

He eventually "arrived" in France in 1929 for duty with the Battle Monuments Commission in Paris. As special assistant to General MacArthur when he was Chief of Staff of the Army, 1933 to 1935, he, as did MacArthur, visioned perils ahead as Germany prepared for another war, and they both worked indefatigably to convince the American people of the need for military preparedness. One can readily see that with such a magnificent and thorough military background Eisenhower should be the man to lead the allied armies to victory.

BOMBARDMENT AVIATION. By Keith Ayling. Harrisburg: Military Service Publishing Company. 234 pp. $2.

WITHIN the limits imposed by official secrecy the author explains what happens when bombing raids are carried out over Europe, how they are planned, what the results are, and just what place bombing plays in World War II. Guilio Douhet, the Italian, believed not only in mass bombardment but in continued mass attacks so that the enemy would not have time to repair the damage. The allied nations have adopted this method. Why the Axis did not is probably due to lack of equipment. It works and works well, and the author tells all of the essential details. Skip bombing and torpedo bombing are not discussed. The principles of bomb sights are explained.

MATHEMATICS FOR EXTERIOR BALLISTICS. By Prof. Gilbert Ames Bliss. New York: John Wiley & Sons, Inc. 128 pp. $2.

THIS text, small though it is, is a most attractive and scholarly presentation of the basic mathematics upon which present-day firing tables are based. Without the information given by such tables the superlative results our artillery is securing all around the world would be impossible. The whole romantic story of the manner in which American mathematicians and scientists sprang into the breach to meet our needs when high-angle and high-

Book Reviews

velocity fire was so rapidly developed during World War I has never been written, but the effects of the work of men of the caliber of Bliss, Moulton, Veblen, and many others are still with us. It is, perhaps, not improper to suggest that the present text is indirectly a by-product of their achievements.

After a preliminary chapter which serves to orient the reader with respect to the necessities of the science and the bases upon which it rests, Professor Bliss, professor emeritus, University of Chicago, devotes a chapter to the development of the differential equations of the trajectory. This is followed by a discussion of the old Siacci theory. He calls attention to the fact that this theory still has application to certain current types of firings.

Methods of solving the differential equations in practice are discussed, including numerical integration and the use of the Bush differential analyzer. The computation of the various kinds of differential corrections which must be applied to correct the standard trajectory to meet the conditions of the day are thoroughly treated. There probably are many places in science and industry where problems analogous to those which meet the gunner arise and which could well be handled by an adaptation of the methods discussed in this work.

NIPPON—THE CRIME AND PUNISHMENT OF JAPAN. By Willis Lamott. New York: John Day Company. 258 pp. $2.50.

THE author lived and taught for nineteen years in Japan. He knows the educational system and places the blame for the national attitude of the Japanese upon it. The myths of Japan's growth and destiny, the ancestry of her imperial family, and her unbending adherence to these fictions have become basic in her teaching and are presented to the youth of Japan as incontrovertible facts. Old Japan is not held up as an essential factor in the present war, but the decade between Mukden in 1931 and Pearl Harbor is clearly presented as background for it. The book is scholarly and timely and gives a clear picture of a people who must be reëducated.

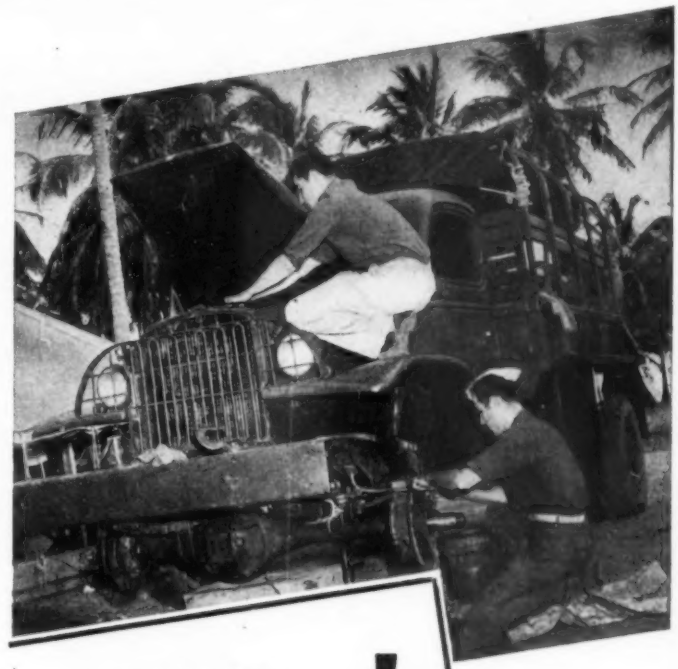
ESSENTIALS OF PRECISION INSPECTION. By Wesley Mollard. New York: McGraw-Hill Book Company. 207 pp. $3.

THIS is essentially a book for use in instruction in the use of modern inspection instruments and gages, including their use in the production of gages themselves. It covers practically the entire range of instruments and gages found in the toolroom of a modern airplane factory. It does not take up the more intricate and specialized gages found in gage laboratories nor the instruments of a multicheck type whereby unskilled workmen can subject pieces to searching inspection on a quantity-production basis. For the field and purpose for which the book appears intended it is an excellent piece of work. Trade schools and apprentice courses should find it of great value.

MATERIALS AND PROCESSES. By J. F. Young. New York: John Wiley & Sons, Inc. 628 pp. $5.

THIS book is far above the average of the materials selection and processing texts which have appeared since the war. Most of the volumes that have come out have had the appearance of being hastily gathered data put together to meet the demand for books to instruct the thousands of new workers in industry. The author of "Materials and Processes," who is on the staff of the engineering general division of the General Electric Company, states that the present volume is one that was especially prepared for the advanced engineering program of that company. It does give the impression that its chapters were well prepared and were based upon considerable experience in teaching the subjects.

The book is limited in its scope to the materials and pro-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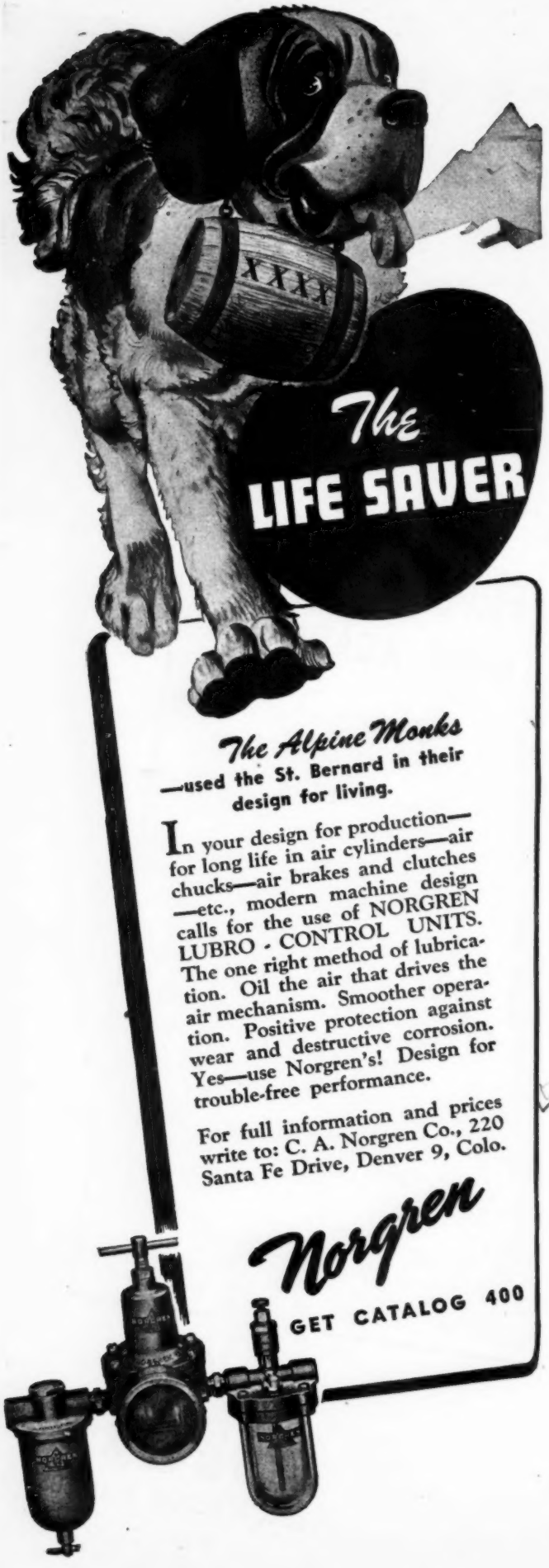
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Book Reviews

cesses used in manufacturing electrical machinery, but it contains good basic data on metals, dielectric materials, plastics, coatings, and finishing materials. In treating of processing, it first gives a background of the original production of the raw metallic materials and then the shop methods of fabricating; namely, casting, forging, molding, die working, welding, drilling, milling, and other machining operations, as well as methods of finishing.

Official Guide to the Army Air Forces. New York: Simon and Schuster. 380 pp. $2.50.

With the Commander in Chief looking out from the frontispiece and with a foreword by Gen. H. H. Arnold, this single authoritative, popular-styled reference source to the mightiest air force in the world takes off. It has been prepared for civilian and military readers and is a thorough compendium of all that is represented by AAF. Here the reader becomes a soldier and views the inner workings of the AAF's vast organization. It is well-indexed and answers to specific questions can be easily found by the interested reader. It is very well illustrated with photographs and sketches. It is useful in the barracks and in the home and will be referred to often. Every copy sold benefits the AAF Aid Society. Since no author is mentioned, it is assumed that the book is a compilation with semiofficial sanction.

Books Received

Tarawa. By Robert Sherrod. New York: Duell, Sloan & Pearce, Inc. 183 pp. $2.

The War in Outline, 1939-1944. Washington: *Infantry Journal*. 228 pp. $0.25.

A Short History of the Army and Navy. By Fletcher Pratt. Washington: *Infantry Journal*. 262 pp. $0.25.

Bricks without Straw. Akron: B. F. Goodrich Company. 45 pp.

The Nazi State. By William Ebenstein. Washington: *Infantry Journal*. 335 pp. $0.25.

The Russian Army. By Walter Kerr. Washington: *Infantry Journal*. 186 pp. $0.25.

West Point. By E. D. J. Waugh. New York: The Macmillan Company. 246 pp. $2.50.

Gas Warfare. By Brig. Gen. Alden H. Waitt. Washington: *Infantry Journal*. 228 pp. $0.25.

Fear in Battle. By John Dollard. Washington: *Infantry Journal*. 64 pp. $0.25.

German Dictionary for the Soldier. By Frank Henius. Washington: *Infantry Journal*. 239 pp. $0.50.

Explosions—Their Anatomy and Destructiveness. By Clark Shove Robinson. New York: McGraw-Hill Book Company. 88 pp.

State of the Nation. By John Dos Passos. Boston: Houghton Mifflin Company. 333 pp. $3.

Minor Surgery. Edited by Humphry Rolleston and Alan Moncrieff. New York: Philosophical Library. 174 pp. $5.

The Officer's Guide. Harrisburg: The Military Service Publishing Company. 553 pp. $2.50.

Valley of the Sky. By Hobert Douglas Skidmore. Boston: Houghton Mifflin Company. 169. pp. $2.

China Looks Forward. By Sun Fo. New York: John Day Company. 276 pp. $3.

Gateway to Asia—Sinkiang. By Martin R. Norins. New York: John Day Company. 200 pp. $2.75.

The War of 1812. By Henry Adams. Washington: *Infantry Journal*. 377 pp. $3.

Fighting Words. By Warfield Lewis. Philadelphia: J. B. Lippincott Company. 330 pp. $3.

No Bright Banner. By Michael DeCapite. New York: John Day Company. 294 pp. $2.50.